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**FIELD SAMPLING PLAN**  
**REVISION: 01**

**RAC CENTRAL FILE**

**ASHLAND/NSP LAKEFRONT  
SUPERFUND SITE**

**ASHLAND, WISCONSIN**

October 2004

**URS**

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## List of Abbreviations

AC	Areas of Concern
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
ch. NR 141	WAC Chapter Natural Resources 141 – Groundwater Monitoring Well Requirements
ch. NR 600	WAC Chapter Natural Resources 600 – Hazardous Waste Rules
CFR	Code of Federal Regulations
CSTAG	Contaminated Sediment Technical Advisory Group
CTE	Central Tendency Exposure
DNAPL	Dense Non Aqueous Phase Liquid
DQO	Data Quality Objective
EPA	Environmental Protection Agency (USEPA)
ERA	Ecological Risk Assessment
FS	Feasibility Study for Remedial Action Options
HHRA	Human Health Risk Assessment
LNAPL	Light Non Aqueous Phase Liquid
MGP	Manufactured Gas Plant
MSL	Mean Sea Level
NAPL	Non Aqueous Phase Liquid
NET	Northern Environmental Technologies, Inc.
NSP	Northern States Power Company
PPE	Personal Protective Equipment
SEH	Short Elliott Hendrickson Inc.
TCLP	Toxicity Characteristic Leaching Procedure
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound
WAC	Wisconsin Administrative Code
WDNR	Wisconsin Department of Natural Resources
WWTP	Wastewater Treatment Plant

## **1.0 INTRODUCTION**

### **1.1 SITE DESCRIPTION**

The Ashland/NSP Lakefront Superfund Site (the "Site") consists of property owned by Northern States Power Company, a Wisconsin corporation (d.b.a. NSPW, a subsidiary of Xcel Energy, Inc. ("NSPW")) a portion of Kreher Park, and sediments in an offshore area adjacent to Kreher Park. The Site is located within the City Limits of Ashland, and is bounded by Lake Shore Drive (also U.S. Highway 2) to the south, Prentice Avenue to the east, Ellis Avenue to the west and Chequamegon Bay to the north. The Site is located in Section 33, Township 48 north, Range 4 west in Ashland County, Wisconsin, shown on Figure 1.

The NSPW facility is located at 301 Lake Shore Drive East in Ashland, Wisconsin. The facility lies approximately 600 feet southeast of the shore of Chequamegon Bay of Lake Superior. The surface elevation at this location is approximately 640 feet MSL. The NSPW property is occupied by a small office building and parking lot fronting on Lakeshore Drive, and a larger vehicle maintenance building and parking lot area located south of St. Claire Street between Prentice Avenue and 3<sup>rd</sup> Avenue East. There is also a gravel covered parking and storage yard area north of St. Claire Street between 3<sup>rd</sup> Avenue East and Prentice Avenue, and a second gravel covered storage yard at the northeast corner of St. Claire Street and Prentice Avenue. Residences bound the property east of the office building and the gravel parking area. Our Lady of the Lake Church and School is located immediately west of the NSPW property. Further west are private residences, beyond which is Ellis Avenue. Private homes are located immediately east of Prentice Avenue, along the eastern boundary of the NSPW property. To the northwest, the Site slopes abruptly to the Canadian National Railroad property at a bluff that marks the former Lake Superior shoreline, and then to the City of Ashland's Kreher Park, beyond which is Chequamegon Bay. This portion of the Site is described as the Upper Bluff/Filled Ravine area. The Upper Bluff Area is shown on Figure 2.

The Kreher Park area consists of a flat terrace adjacent to the Chequamegon Bay shoreline. The surface elevation of the park varies approximately 10 feet, from 601 feet MSL, to about 610 MSL at the base of the bluff overlooking the park. The bluff rises to an elevation of about 640 feet MSL, which corresponds to the approximate elevation of the NSPW property. The lake

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elevation fluctuates about two feet, from 601 to 603 feet MSL. At the present time, the park area is predominantly grass covered. A graveled overflow parking area for the marina occupies the west end of the property, while a miniature golf facility formerly occupied the east end of the property. The former City of Ashland wastewater treatment plant (WWTP) and associated structures fronts the bay inlet on the north side of the property. The impacted area of Kreher Park is bounded by Prentice Avenue and a jetty extension of Prentice Avenue to the east, the Canadian National Railroad to the south, the Ellis Avenue and the marina extension of Ellis Avenue to the west, and Chequamegon Bay to the north.

The offshore area with impacted sediments occupies approximately ten acres and is located in an inlet created by the Prentice Avenue jetty and marina extensions previously described. For the most part, contaminated sediments are confined in the inlet bounded by the northern edge of the line between the Prentice Avenue jetty and the marina extension. Contaminated sediment levels fall off beyond this boundary. The affected sediments consist of lake bottom sand and silts and are overlain by a layer of wood chips, likely originating from former lumbering operations. The chips layer varies in thickness from 0 to seven feet, with an average thickness of 0.75 feet.

## **1.2 SITE HISTORY AND BACKGROUND**

Between 1885 and 1947, gas was generated for heating and lighting at a former manufactured gas plant (MGP) located at the NSPW property. Manufactured gas plant wastes containing hazardous substances were released during the gas manufacturing process at the former MGP. The former MGP property was transected on the north by a ravine that deepened and opened to the historic shoreline of Chequamegon Bay along the bluff face that overlooks the Bay. Historical maps show that the ravine was open at the startup of gas production at the former MGP in the late 1880s and was filled by the early 1900s.

The lakefront portion of the Site has been the location of historic industrial activities, and currently consists of an area owned by the City of Ashland known as Kreher Park. Kreher Park was created in the late 1800s and early 1900s by the placement of various fill materials in Chequamegon Bay adjacent to the bluff. The fill material consists mainly of sawdust and wood wastes from a series of sawmills that operated at the Lakefront from the early 1880s until approximately 1939, most recently by the John Schroeder Lumber Company ("Schroeder Lumber"). Schroeder Lumber occupied the site from 1901 until 1939, when Ashland County

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took title to the site. Following Schroeder Lumber's tenure, Ashland County transferred title to the City of Ashland in 1942, which has owned the site since. During the 1940's and 50's, the City operated a waste disposal facility (landfill) in the present northwest portion of the Park area. Beginning in 1951, a WWTP was constructed, and operated as the City's sewage treatment facility until 1989. During the mid-1980's, the marina extension of Ellis Avenue was completed, which created more usable land to permit establishment of a marina with full service boat slips, fuel and dock facilities. In 1989 during exploratory work to expand the WWTP into the Kreher Park area, soil and groundwater contaminated with creosote/coal tar<sup>1</sup> compounds were encountered. The City notified the Wisconsin Department of Natural Resources (WDNR), and subsequently closed the WWTP, relocating the current facility a few miles away to the northeast.

In 1994, the WDNR authorized Short Elliot Hendrickson (SEH) to initiate an investigation and evaluation of the area to characterize the extent of contamination at Kreher Park and offshore sediments adjacent to the Park. The affected sediments consist of lake bottom sand and silts, and are overlain by a layer of wood chips, likely originating from former lumbering operations. The chips layer varies in thickness from 0 to seven feet, with an average thickness of nine inches. The entire area of impacted sediments encompasses approximately ten acres.

Since 1995, NSPW performed several investigations to characterize the extent of contamination in the buried ravine and Copper Falls Aquifer in the Upper Bluff Area. These investigations confirm that the ravine fill is a low permeability, mixed fill consisting of clays, cinders and rubble, with saturated conditions at depths varying from five feet below the NSPW service building, to about 20 feet at the north end of the gravel covered storage area. These investigations have also identified subsurface contamination resulting from historic MGP operations. Contamination exists as dissolved phase coal tar constituents in groundwater and as "pools" of non-aqueous phase liquid (NAPL) of coal tar by-product. Coal tar has been encountered at the base of the ravine and in the underlying Copper Falls Aquifer. In the ravine, coal tar varying from one to two feet in thickness is present at the base of the ravine from south of the service facility north to the area of St. Claire Street. In the upper Copper Falls Aquifer, coal tar has been encountered from south of the service facility north to the gravel parking and storage yard area north of St. Claire Street. It has also been measured in a piezometer installed

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<sup>1</sup> The term "coal tar" is used generically herein to refer to a suite of VOC and PAH compounds the source of which was the former MGP and other lakefront industrial activities.

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on the Our Lady of the Lake church property west of Third Avenue East. It has not been measured in wells screened in the Copper Falls aquifer north of the bluff face at Kreher Park.

NSPW installed an interim action coal tar recovery system on its property to remove coal tar from the Copper Falls Aquifer during the summer/fall of 2000; the system became fully operational in January 2001. The coal tar recovery system consists of three extraction wells, an oil/water separator, and an on-site groundwater treatment system. Groundwater samples have been collected quarterly since the coal tar recovery system began operating, and results have been presented in progress reports. More than 6,400 gallons of coal tar has been removed, and more than 1,000,000 gallons of contaminated groundwater has been treated between January 2001 and August 2004.

A distinct DNAPL pool varying in thickness up to five feet was present in the area around the former seep located in Kreher Park just north of the mouth of the former ravine. A clay tile that discharged to the "seep" area (located north of the mouth of the buried ravine at the railroad)<sup>2</sup> was encountered at the base of the backfilled ravine during investigations completed between September and November 2001. Coal tar encountered in the shallow southern portion of the ravine near the former MGP building provides a source for contaminated groundwater flow, north through the former ravine into Kreher Park. However, the contaminant levels measured in wells screened in the ravine north of St. Claire Street are significantly lower than wells screened in the ravine south of St. Claire Street (where free-product coal tar is present), or at the former seep. The buried clay tile likely behaved as a conduit for the migration of coal tar as well as contaminated groundwater. However, a significant portion of the clay tile was destroyed during the 2001 investigation activities. NSPW performed a second interim removal response during May 2002 to eliminate the seep area. Activities completed included the excavation of contaminated soil in the seep area, the placement of a low permeability cap over the seep area, and the installation of a groundwater extraction well installed at the base of the buried ravine. Contaminated groundwater collected near the mouth of the ravine via this extraction well is conveyed to the on-site treatment system described above. (Figure 2 shows the location of the extraction wells, EW-1 through EW-4, and the treatment building located on the NSPW property.)

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<sup>2</sup> The seep area had been the location of intermittent groundwater discharge containing a sheen and occasional odor of coal tar, until NSPW performed the seep removal interim action in 2002.

### 1.3 SAMPLING OBJECTIVES

The overall goal of the RI/FS process is to collect sufficient data to characterize the extent of contamination at the Site and provide a feasibility study for a range of potential remedial options leading to the USEPA's selection of a proposed remedial action for the Site.

Additional site investigation data and historic site investigation data will be used to evaluate potential exposure pathways to review potential remedial alternatives protective of human health and the environment. Data collected during the RI, in addition to historic data, will be utilized to meet the specific objectives described in Section 1.2 of the RI/FS Work Plan.

The objectives of this FSP are to:

- Present the rationale for the number and types of environmental samples to be collected during the field investigation;
- Present the rationale for the selection of sampling locations;
- Describe the procedures to be used for collection, preservation, packaging, and transport of environmental samples;
- Describe the procedures to be used to perform a geophysical survey and video-logging of selected site wells;
- Present documentation requirements for sample activities and sample custody;
- Describe the procedures for decontamination of environmental sampling equipment;
- Describe the procedure for disposal of Investigative Derived Waste (IDW); and
- Provide a schedule for the field investigation.

This FSP is a document that field personnel can rely on to collect the required samples without compromising the integrity of the samples or data. The information presented in this FSP will enable field personnel to collect the samples in a manner that meets project Data Quality Objectives (DQOs). Accordingly, the intent of this FSP is to provide the informational procedures required to implement the program outlined in the RI/FS Work Plan for the Site.

## **2.0 FIELD ACTIVITIES**

### **2.1 MOBILIZATION AND SITE ACCESS**

#### **2.1.1 Pre-Investigation Activities**

Much of the field investigation activities will take place intermittently over the course of a 12-16 month span. To reduce potential problems in the field, the following tasks, at a minimum, should be completed before conducting field activities:

- Discuss scheduled sampling activities with the NSPW Project Coordinator. The Project Coordinator is required to notify USEPA no less than 14 days prior to sample collection;
- Contact laboratory to review analytical requirements, provide sample containers, and discuss delivery/pickup of coolers/packages;
- Contact subcontractors to review scope of work, schedule field activities, and discuss special equipment needs;
- Contact Diggers Hotline if drilling/excavating activities are scheduled;
- Receive permission to access privately/City of Ashland owned properties;
- Secure specialized equipment needed to complete field activities; and
- Review scope of work with Project Manager to identify potential problems.

#### **2.1.2 Site Access**

Site access is of the utmost importance to protect the public from exposure to contaminants at the site during field investigation activities. All visitors must check in with the Field Manager before being allowed on-site. Visitor information (i.e. affiliation, reason for being at site, etc.) will be documented in the field logbook. Unpermitted visitors will not be allowed on-site. Visitors will only be allowed to enter the exclusion zone with permission from the project manager and proof of 40-hour HAZWOPER training. These visitors will be required to present a copy of their completion certificates of 40-hour HAZWOPER training and 8-hour refresher training to the site safety officer for inclusion in the HASP. All personnel entering the site will review the Site Health and Safety Plan (HASP).

A portion of the field investigation is taking place at the Our Lady of the Lake School/Church property. It is crucial that the field manager coordinate with representatives of the School before commencing field activities, to minimize disturbance to the school activities. Field activities should be scheduled when students are not using exterior areas of the property. For all field activities at this property, the exclusion zone will be secured with either traffic cones or caution tape.

Additionally, field investigation activities are taking place at Kreher Park. This area is used by the public for recreational purposes. For all field activities at Kreher Park, the exclusion zone will be secured with either traffic cones or caution tape. Excavations advanced at Kreher Park will be backfilled with clean fill before the end of the day to eliminate the possibility of exposure to contaminants when work is not taking place.

### 2.1.3 Field Standard Operating Procedures

Standard operating procedures (SOP) referenced in this document are listed below. The individual SOPs are included in Appendix A.

SOP Number	Description
100	Water Level Measurement
110	Groundwater Field Parameter Measurement
120	Monitoring Well Installation, Development, and Abandonment
130	Exploration Test Pits
140	Soil Sample Collection
150	Groundwater Sample Collection
160	VOC, SVOC, and Inorganic Sample Collection
170	Field Filtering Groundwater Samples
180	Quality Control Sampling
190	Decontamination of Sampling Equipment
200	Summa Canister VOC Sample Collection
210	Shipping Environmental Samples
220	Decontamination of Heavy Equipment
230	Fish Tissue Sample Collection
240	Sediment Sampling for Toxicity Testing and Benthic Community Analysis and Bioavailability Analysis
250	Sediment Sampling for Chemical and Physical Parameter Testing
260	Field Screening Procedures
270	Non-Aqueous Phase Liquid Measurement

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280	Placement of ADCP and Pressure Transducer
290	Collection of Core Samples for Sediment Stability Studies
300	Porewater Sampling Using Diffusion Sampling Vessels
310	Surface Water Sample Collection
320	Collection of Radiometric Data for Calculation of In Situ Extinction Coefficients for Laboratory Ultraviolet Light Exposures
330	Sediment Toxicity Testing and Bioaccumulation
335	Fat Head Minnow Bioassay With and Without Ultraviolet Light
340	Lab Procedures for Radiometric Analysis
350	Lab Procedures for Benthic Macroinvertebrate Community Analysis

## **2.2 SURFACE SOIL SAMPLE INVESTIGATION**

Surface soil samples are defined as samples from the 0 to 1 foot below grade. Surface soil samples will be collected in the upper bluff area in the vicinity of the former MGP and in Kreher Park as described below. Results will be collected to determine if there are any contaminants on the surface, serving as a direct contact threat to human health and the environment. At each sample location, soil will be collected from a depth between 0 and 12-inches utilizing hand tools. Samples will be placed in laboratory containers, held on ice, and shipped to the laboratory along with a completed chain-of-custody form. All samples will be analyzed for VOCs, SVOCs, and inorganic compounds included in Table 1 of this field sampling plan. Surface soil samples will be collected in accordance with SOP 140 included in the FSP.

### **2.2.1 Sample Location and Frequency**

In Kreher Park, surface soil samples will be collected from all proposed exploration test pit locations. A total of 21 exploration test pits will be completed in the vicinity of the former solid waste disposal and the former coal tar dump areas to identify the limits of solid waste and/or contamination in these areas. Three additional surface soil samples will also be collected in Kreher Park outside the former solid waste disposal and the former coal tar dump areas. Sample SS-11 will be collected on the north side of the former City wastewater treatment plant. Sample SS-12 will be collected between the former solid waste disposal and the former coal tar dump areas, and sample SS-13 will be collected east of the former coal tar dump area. Proposed test pit locations and proposed surface soil sample locations in Kreher Park are shown on Figure 4.

Previous investigations in the vicinity of the former MGP have shown that subsurface soil contamination at the upper bluff is generally limited to the backfilled ravine; most of this area is

covered by facility buildings, gravel, asphalt pavement, or City streets. Samples SS-14 through SS-21 will be collected from unpaved areas in the vicinity of the former MGP facility and filled ravine area. The SS-14 sample is located on the east side of the former ravine east of the former MGP facility building. Samples SS-15 and SS-16 are located northwest of the former MGP facility on the west side of the backfilled ravine. The SS-17 and SS-18 samples are located within the footprint of the backfilled ravine northwest of the former MGP facility. Samples SS-19, SS-20, SS-21 and SS-22 are located west of the former MGP facility on the west side of the backfilled ravine. Samples SS-23 and SS-24 are located in the residential area south of the backfilled ravine and the former MGP facility, and sample SS-25 is located southeast of the backfilled ravine and the former MGP facility along Prentice Avenue. Samples collected from the SS-22, SS-23, SS-24, and SS-25 locations will be used to represent background conditions. Soil sample locations SS-14 through SS-25 are shown on Figures 2 and 3.

The exact locations of these soil borings may differ in the field and are contingent on the accurate locating of underground utilities and safety of the field personnel (URS and subcontractor). All surface soil samples will be collected in accordance with Standard Operating Procedure (SOP) 140.

## **2.2.2 Sample Collection Procedures**

### **2.2.2.1 Sampling Equipment**

Surface soil samples will be collected using hand tools, clean spatulas, a scale for weighing samples and laboratory supplied containers. Appropriate personal protective equipment (PPE), as specified in the Health and Safety Plan for surface soil sampling will be utilized. Surface borings will be advanced using hand augers or hand tools (shovel or trowel). A photoionization detector (PID) will be used to measure organic vapor concentrations of the sample headspace. A comprehensive list of equipment needed is described in SOP 140.

### **2.2.2.2 Sample Collection**

All details regarding surface soil sample collection will be recorded in the field logbook. Section 3.1 described documentation requirements for sampling activities. At each surficial soil sample location for direct contact conditions, soil will be collected from a depth between 3 and 12 inches



utilizing hand tools or hand augers. Procedures for soil sample collection are described in SOP 140. The samples will be analyzed with a PID to measure headspace concentrations of organic vapors in each sample prior to containerization. Procedures for field screening are described in SOP 260. Sampling equipment will be decontaminated by brushing with detergent water and triple rinsing with distilled water between boring locations. Decontamination procedures are described in SOP 190.

#### **2.2.2.3 Sample Containerization**

Soil samples will be placed in appropriate laboratory supplied containers. Samples will be placed in containers and preserved in accordance with the analytical requirements listed in Table 1. For VOC analysis, approximately 25 to 35 grams of soil will be weighed using a scale and placed in a laboratory supplied container. One vial of methanol, supplied by the laboratory will be added to the container prior to sealing the cap. Procedures for filling laboratory containers are described in SOP 160.

#### **2.2.3 Sample Handling and Analysis**

Proper field sampling documentation and field analytical and laboratory documentation helps to ensure sample authenticity and data integrity. Methods for assigning unique sample names are described in Section 3.2 of this FSP. The unique sample name will be used for the sample containers and chain of custody. Procedures for sample shipping are described in SOP 210. Analyses required for surface soil samples are listed on Table 1. Surface soil samples will be analyzed for VOCs (EPA 8260), SVOCs (8270C), Cyanide (EPA 335.4), Hexavalent Chromium (EPA 7196A), and metals (EPA 6010B/7471A). A complete list of analytes is shown on Table 2. Northern Lake Service, of Crandon, Wisconsin will provide soil analytical services.

### **2.3 SUBSURFACE SOIL SAMPLE INVESTIGATION**

#### **2.3.1 Sample Location and Frequency**

The field investigation within the upper bluff and ravine fill area will include the collection of additional soil samples from Geoprobe soil borings advanced to the backfilled ravine and the collection of soil samples around the perimeter of the former MGP. The purpose of these samples is to investigate the known locations of the former gas holders and other potential sources at the former MGP. The additional soil samples will be collected from approximately 38

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Geoprobe borings advanced in a regular grid pattern south of St. Claire Street in the courtyard area, inside the portion of the NSPW building between the courtyard and alley, and in the alley. The grid pattern will be spaced approximately 20 feet. Four borings will also be advanced inside the former MGP building south of well nest MW-8/8A. Soil sample locations are shown on Figure 2. Geoprobe borings will be advanced in two-foot intervals, a minimum of five feet below the base of the filled ravine, or to a maximum depth of 20 feet. Samples from each two-foot interval will be field screened with a PID to select samples for laboratory analysis. A minimum of three samples per boring will be collected for laboratory analysis. Determination of the three samples for laboratory analysis is as follows:

1. A sample collected from the unsaturated zone.
2. A sample with the highest PID headspace measurement; or the base of the backfilled ravine if contamination is not encountered.
3. A sample collected from the deepest interval, or from the deepest interval where PID headspace measurement indicates contamination is not present.

Additional subsurface soil samples will also be collected from three Geoprobe borings to evaluate background conditions. Background subsurface soil samples will be collected at intervals of 5, 10, and 15 feet from three borings advanced on the NSPW property south of the former MGP. These three borings will be advanced within 15 feet of the North side of Lakeshore Drive between Prentice and 3<sup>rd</sup> Avenues at locations 50, 100, and 150 feet west of Prentice Avenue. These three borings were selected to represent upgradient soil background conditions outside the limits of the filled ravine. Three samples per boring will be selected for laboratory analysis. The proposed subsurface sample locations are shown on Figure 2. Subsurface soil samples will be submitted for analysis of VOCs, SVOCs, and inorganic constituents as shown on Table 2. All subsurface soil samples will be collected in accordance with SOP 140.

At Kreher Park, approximately 12 Geoprobe borings will be advanced in the vicinity of the former seep area, and approximately 8 borings will be advanced in the vicinity of well TW-11; additional borings will be advanced as needed. The purpose of these samples is to identify the lateral extent of free-phase hydrocarbons in these areas. The proposed subsurface soil sample locations are shown on Figure 3. All subsurface soil samples will be collected in accordance with the SOP 140.

## **2.3.2 Subsurface Soil Sample Collection Procedures**

### **2.3.2.1 Sampling Equipment**

Subsurface soil samples will be collected using direct-push techniques (Geoprobe). Required sampling equipment includes: clean spatulas, a scale for weighing samples and laboratory supplied containers. A comprehensive list of equipment needed is listed in SOP 140. Sampling equipment will be decontaminated between boring locations. Decontamination procedures are described in SOP 190.

### **2.3.2.2 Sample Collection**

All details regarding subsurface soil sample collection will be recorded in the field logbook. These details include sample location, date, time, attempted and recovered length, color, moisture content, texture, odor, description per USCS, and whether or not the sample was submitted for laboratory analysis. Geoprobe borings will be advanced a minimum of five feet below the base of the filled ravine, or to a maximum depth of 20 feet in the Upper Bluff/Ravine area. Geoprobe borings will be advanced to the underlying clay layer (Miller Creek formation) or to a maximum depth of 15 feet in the Kreher Park area. Soil samples will be collected continuously and visually classified by a geologist or qualified geological engineer. A minimum of three samples per boring will be collected for laboratory analysis. Procedures for soil sample collection are described in SOP 140.

### **2.3.2.3 Field Screening Procedures**

Samples will be collected every two feet and screened with a photo-ionization detector (PID) equipped with a 10.6 eV lamp. The field screening results will be used to select soil samples for laboratory analysis. Procedures for field screening are described in SOP 260.

### **2.3.2.4 Sample Containerization**

Soil samples will be placed in appropriate laboratory supplied containers. Samples be placed in containers and preserved in accordance with the analytical requirements listed in Table 1. Procedures for filling laboratory containers are described in SOP 160.

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### **2.3.3 Sample Handling and Analysis**

Proper field sampling documentation, and field analytical and laboratory documentation helps to ensure sample authenticity and data integrity. Section 3.2 of this FSP describes the methods for assigning unique sample names. The unique sample name will be used for the sample containers and chain of custody. Procedures for sample shipping are described in SOP 210. Analyses required for subsurface soil samples are listed on Table 1. Northern Lake Service, of Crandon, Wisconsin will provide soil analytical services.

## **2.4 GROUNDWATER QUALITY INVESTIGATION**

### **2.4.1 Monitoring Well Installation**

The installation of additional monitoring wells is not anticipated for the completion of the RI/FS. However, the following sections describe procedures for installing monitoring wells and piezometers for this RI/FS.

All monitoring wells will be constructed in accordance with procedures outlined in Wisconsin Administrative Code, Chapter NR 141, Groundwater Monitoring Well Requirements (NR 141). Monitoring wells will be installed using either hollow stem auger or mud rotary drilling methods. Procedures for the installation of monitoring wells are described in SOP 120

#### **2.4.1.1 Construction Materials**

Well casings will consist of two-inch diameter, flush-threaded, polyvinyl chloride (PVC) materials. In wells less than 100 feet in depth, Schedule 40 PVC well casings and screens will be used. In wells deeper than 100 feet, Schedule 80 PVC well casings and screens will be used. In instances where NAPL may interact with PVC and cause degradation, alternative construction materials may be used with prior approval from the EPA RPM. Wells screens for water table wells will be 10 feet in length and wells screens for piezometers will be 5 feet in length. All wells screens will have a slot size of 0.010 inches with a slot spacing of 0.125 inches.

A silica-based, sand filter pack will be placed by gravity in the annular space surrounding the well screen and extend a minimum of two feet above the top of the well screen. A filter pack seal consisting of fine sand will be placed by gravity to a minimum of two feet above the sand

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filter pack. In formations where the depth of standing water is less than 30 feet and the total depth of the annular space seal is less than 50 feet, 3/8 inch diameter bentonite chips will be placed by gravity to seal the annular space. For all other wells, a high-solids grout will be tremied in place to seal the annular space. The ground surface seal shall consist of bentonite chips or cement.

#### **2.4.2 Monitoring Well Development**

The installed wells will be developed in accordance with NR 141.21 Wisconsin Administrative Code requirements. Wells will be developed using decontaminated or dedicated sampling equipment to reduce the possibility for cross contamination. Purge water collected during well development will be disposed of at the on-site remediation system. Procedures for monitoring well development are described in SOP 120.

#### **2.4.3 Monitoring Well/Borehole Abandonment**

Any boreholes or wells designated for abandonment will be completed accordance with NR 141.25 Wisconsin Administrative Code requirements. These abandonment requirements must be met for all boreholes that are greater than 10 feet or intersect the water table and all monitoring wells and piezometers. Boreholes will be abandoned by the complete filling of the borehole with bentonite granules, chips, or bentonite slurry. A tremie pipe will be used to deliver sealing materials in boreholes and wells that are greater than 30 feet in depth or with standing water. Procedures for borehole abandonment are described in SOP 120.

#### **2.4.4 Sample Location and Frequency**

##### ***Upper Bluff Area - Groundwater Sample Collection***

Groundwater will be sampled from 16 monitoring wells screened in the Miller Creek Formation or the filled ravine. The purpose of sampling these wells is to evaluate water quality and groundwater flow conditions at these locations. These wells include:

Miller Creek Formation Wells	Well Position <sup>(1)</sup>	Filled Ravine Wells	Well Position <sup>(1)</sup>
MW-8	sidegradient	MW-1	downgradient
MW-10	sidegradient	MW-2R	downgradient
MW-11	sidegradient	MW-3	downgradient
MW-16	upgradient	MW-4	upgradient
MW-17	sidegradient	MW-5	downgradient
		MW-6	upgradient
		MW-7R	downgradient
		MW-9	downgradient
		TW-13	downgradient
		MW-14	downgradient
		MW-15	upgradient

<sup>(1)</sup> Position is relevant to former MGP features shown on Figure 2.

The locations of these wells are shown on Figure 2. The wells will be sampled quarterly for six rounds for this remedial investigation. The target parameters (field and laboratory analysis), and the frequency of monitoring is shown in Table 1. Procedures for collecting groundwater samples are described in Section 2.4.5. All groundwater samples will be collected in accordance with SOP 150.

#### ***Copper Falls Aquifer – Groundwater Sample Collection***

Following piezometer installation, groundwater will be sampled from 41 piezometers screened in the Copper Falls aquifer. The purpose of these samples is to better define the extent of the free product plume and provide additional information on the down gradient extent of the dissolved phase plume. These wells include:

Copper Falls Aquifer Piezometers						
MW-2AR	MW-5B	MW-9A	MW-13C	MW-18B	MW-22A	MW-26A
MW-2BR	MW-5C	MW-9B	MW-13D	MW-19A	MW-22B	MW-2A(NET)
MW-2C	MW-6A	MW-10A	MW-15A	MW-19B	MW-23A	MW-2B(NET)
MW-4A	MW-7A	MW-10B	MW-15B	MW-20A	MW-23B	AW-1
MW-4B	MW-7B*	MW-13A	MW-17A	MW-21A	MW-24A	AW-2
MW-5A	MW-8A	MW-13B	MW-18A	MW-21B	MW-25A	

The locations of these wells are shown on Figure 2 and Figure 3. The wells will be sampled quarterly for six rounds for this remedial investigation. The target parameters (field and laboratory analysis), and the frequency of monitoring is shown in Table 1. All groundwater samples will be collected in accordance with SOP 150.

#### ***Kreher Park – Groundwater Sample Collection***

Groundwater will be sampled from ten monitoring wells screened in the Kreher Park fill aquifer. The purpose of these samples is to provide additional information of both the flow and contaminant mass-loading to surface water. These wells include:

Kreher Park Wells	
MW-1 (NET)	TW-11
MW-2 (NET)	TW-12
MW-3 (NET)	MW-24*
MW-7R	MW-25*
TW-9	MW-26*

The locations of these wells are shown on Figure 3. The wells will be sampled quarterly for two additional rounds for this remedial investigation (December 2004 and March 2005). The target parameters (field and laboratory analysis), and the frequency of monitoring are shown in Table 1.

#### **2.4.5 Groundwater Sample Collection Procedures**

##### ***2.4.5.1 Sampling Equipment***

Each well will be purged with a dedicated or decontaminated bailer or submersible pump. A comprehensive list of sampling equipment needed is listed on SOP 150.

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#### **2.4.5.2 Sample Collection**

All details regarding subsurface groundwater sample collection will be recorded in the field logbook. The condition of the well will also be recorded at the time of sample collection. Groundwater samples will be collected from the monitoring wells listed in Sections 2.1.5, 2.2.1 and 2.3.4 of this Field Sampling Plan. The procedure for collecting groundwater samples is described in SOP 150.

*Prior to sample collection, static water levels will be measured in all site wells with a water level indicator. The procedures for using the water level indicator are described in SOP 100.*

Wells suspected to contain non-aqueous phase liquids (NAPLs) should be measured prior to sample collection. SOP 270 describes procedures for measuring NAPLs. Wells containing more than one foot of NAPL will not be sampled.

Each well will be purged with a dedicated/decontaminated bailer or submersible pump. Each well will be purged until at least four times the volume of water in the well has been removed. Additionally, field measured parameters must stabilize for purging to be complete. At least three consecutive readings spaced approximately 2 minutes, or 0.5 well volumes or more apart, are within the following ranges for the following indicator parameters:

- Specific Conductance       $\pm 5.0 \mu\text{mhos/cm}$  for values  $<1000 \mu\text{mhos/cm}$   
    $\pm 10.0 \mu\text{mhos/cm}$  for values  $>1000 \mu\text{mhos/cm}$
- pH                                       $\pm 0.1$  pH units
- Temperature                       $\pm 0.1$  °C
- Dissolved Oxygen                 $\pm 0.2$  mg/L

Quality assurance objectives for groundwater field parameters are listed on Table 4. For low permeability formations, purging will continue until the well is dry. If time permits, the well will be allowed to recover completely and bail dry a second time. Purge volumes and the color, odor, and turbidity of each will be noted on field sampling forms. The condition of the well will also be recorded at the time of sample collection. The procedures for measuring groundwater field parameters are detailed in SOP 110.



#### **2.4.5.3 Sample Containerization**

Groundwater samples will be placed in appropriate laboratory supplied containers. Samples will be placed in containers and preserved in accordance with the analytical requirements listed in Table 1. Procedures for filling laboratory containers are described in SOP 160. Samples submitted for dissolved analytes will need to be field filtered prior to placement in containers. Procedures for field filtering are described in SOP 170.

#### **2.4.6 Sample Handling and Analysis**

Proper field sampling documentation, and field analytical and laboratory documentation helps to ensure sample authenticity and data integrity. Section 3.2 of this FSP describes the methods for assigning unique sample names. The unique sample name will be used for the sample containers and chain of custody. Procedures for sample shipping are described in SOP 210. Analyses required for groundwater samples are listed on Table 1. A complete list of analytes is shown on Table 2. Northern Lake Service, of Crandon, Wisconsin will provide groundwater analytical services.

### **2.5 SEDIMENT QUALITY TRIAD INVESTIGATION**

A Sediment Quality Triad (Triad) approach will be conducted to evaluate the potential for toxicity of Site sediment to sediment-dwelling invertebrates. The Triad approach evaluates sediment quality by integrating spatially and temporally matched sediment chemistry, biological, and toxicological information. Benthic invertebrate community analysis and sediment toxicity testing provide site-specific information regarding potential ecological effects of exposure of ecological receptors to COPCs in the Site sediment. These additional lines of evidence supplement traditional sediment chemistry data to provide a more relevant, site-specific assessment of risks.

The sediment triad sampling will evaluate chemical, biological and toxicological indices for sediment dwelling organisms to support the ecological risk assessment (ERA). Three parameters will be assessed as part of this sampling effort:

- Bulk sediment chemistry
- Sediment toxicity; and

- Benthic community structure.

### ***Station Selection***

The results of all previous sediment sampling will be used to identify candidate stations to be sampled for the Triad study. Using GIS, likely gradients of total PAH concentrations from 0 to approximately 300 µg/g will be extrapolated. This concentration gradient will be positioned along Site areas expected to have both wood waste, mixed wood waste and mineral substrate and absence of wood waste. Ideally, a combination of substrate types will be represented from two stations from each of the following intervals, 0-50 µg/g, 50-100 µg/g, 100-150 µg/g and 150-300 µg/g. Candidate Triad stations are depicted in Figure 5.

Selection of reference areas will focus on identification of areas outside the Site inlet that are expected to have variable substrate types. In addition to the reconnaissance discussed above which will be used to identify two reference stations having primarily mineral substrate and two primarily wood waste substrate, preliminary sampling will be conducted to ensure that reference stations have not been impacted by Site COPCs. Candidate Triad reference stations are depicted in Figure 5.

### **2.5.1 Preliminary Sediment Sampling**

To aid in final selection of reference stations and Site stations for the Triad study, preliminary sediment sampling will be conducted. Three samples in the vicinity of each candidate Site station and reference station will be collected using a ponar grab or core sampler in accordance with SOP 250 and analyzed for total PAHs. The three sampling locations will be located as follows:

- 1) The first sampling location will be located by GPS coordinates taken from Figure 5. This figure has located candidate Site stations based upon previous data (i.e. locations of target concentration ranges of total PAHs 0-50, 50-100, 100-150, 150-300 ppm). Candidate reference stations will be identified in the field using exploratory techniques described in Section 4.3.3.4.2.2 of the RI/FS workplan.

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- 2) A sediment sample will be collected from the initial station and from two more stations, approximately 10 and 20 meters, respectively, in a direction of 315° magnetic from the initial station (See Figure 5)

Once the results from these preliminary samples are available, they will be used to finalize selection of Site stations and reference stations. Stations in the target concentrations ranges as described previously will be selected. In the case of the reference stations, the preliminary results will be used to make sure that Site contaminants (as indicated by elevated levels of naphthalene) are not present in the reference area.

#### ***2.5.1.1 Sampling Equipment***

Sampling equipment needed to collect the samples includes a boat, Ponar sampler or core sampler, GPS unit, sample containers, and appropriate PPE as required by the HSP. A comprehensive list of sampling equipment is listed in SOP 250.

#### ***2.5.1.2 Sample Collection***

All details regarding sample collection will be recorded in the field logbook. Samples will be collected using a Ponar or coring device. Procedures for sediment sampling are described in SOP 250.

#### ***2.5.1.3 Sample Handling and Analysis***

Proper field sampling documentation and field analytical and laboratory documentation helps to ensure sample authenticity and data integrity. Section 3.2 of this FSP describes the methods for assigning unique sample names. The unique sample name will be used for the sample containers and chain of custody. Procedures for sample shipping are described in SOP 210. Analyses required for preliminary sediment samples are listed on Table 1. Northern Lake Service, of Crandon, Wisconsin will provide soil analytical services.

### **2.5.2 Sediment Samples**

Once final locations of Triad study and reference stations have been selected, sediment will be collected as described in SOP 250 and analyzed for VOCs, SVOCs and metals in bulk sediment.

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Bulk sediment samples from each of the replicate samples will be analyzed for sediment chemistry, and total organic carbon (TOC). Grain size testing will also be performed using methods in accordance with ASTM D422. One composite sample from each station will be evaluated for PAH forensics. One sample from each station will be analyzed for pore water chemistry (SOP 300). In addition AVS: SEM analysis will be conducted on one of the replicates from each station.

#### **2.5.2.1 Sampling Equipment**

Sampling equipment needed to collect the samples includes a boat, Ponar sampler or coring device, sample containers, and appropriate PPE as required by the HSP. A comprehensive list of sampling equipment is listed in SOP 250.

#### **2.5.2.2 Sample Collection**

All details regarding sample collection will be recorded in the field logbook. Samples will be collected using either a Ponar sampler or or other coring device. Procedures for sediment sampling are described in SOP 250.

#### **2.5.2.3 Sample Handling and Analysis**

Proper field sampling documentation and field analytical and laboratory documentation helps to ensure sample authenticity and data integrity. Section 3.2 of this FSP describes the methods for assigning unique sample names. The unique sample name will be used for the sample containers and chain of custody. Procedures for sample shipping are described in SOP 210. Analyses required for the samples are listed on Table 1. The laboratories providing analytical services will be identified later.

#### **2.5.3 Bioavailability Samples**

Sediment samples selected for forensic PAH analysis will be collected as described in SOP 240. Forensic PAH analysis will be conducted on a subsample of the composite sediment sample from each of the Triad and reference stations. This subsample will be from the same composite sample used in the bioassays.

In addition to forensic analysis of PAHs, the amount of soot-phase black carbon (soot) as well as coal will be analyzed from each of the composite sample from each Site and reference station.

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Microscopic inspection of the larger particle sizes to evaluate the amount of coal particles or coal dust in the sample will also be performed.

The determination of soot is based upon the method of Accardi-Dey and Gschwend (2003). Microscopic inspection of samples using reflected light organic petrology methods (Stach 1982) also will be conducted and reflectance of organic particles (soot, lamp black, and coal) will be quantitatively measured for source identification purposes.

#### **2.5.3.1 Sampling Equipment**

Sampling equipment needed to collect the samples includes a boat, Ponar sampler or coring device, sample containers, and appropriate PPE as required by the HSP. A comprehensive list of sampling equipment is listed in SOP 240.

#### **2.5.3.2 Sample Collection**

All details regarding sample collection will be recorded in the field logbook. Samples will be collected using either a Ponar sampler, or coring device. Sediment will be collected from the bioactive zone, defined as the upper four inches of the sediment column. Procedures for sediment sampling for bioavailability analyses are described in SOP 240.

#### **2.5.3.3 Sample Handling and Analysis**

Proper field sampling documentation and field analytical and laboratory documentation helps to ensure sample authenticity and data integrity. Section 3.2 of this FSP describes the methods for assigning unique sample names. The unique sample name will be used for the sample containers and chain of custody. Procedures for sample shipping are described in SOP 210. Analyses required for the samples are listed on Table 1. The laboratory providing analytical services will be identified later.

#### **2.5.4 Benthic Community Investigation**

The incorporation of benthic invertebrate community data into a Triad evaluation provides an *in situ* evaluation of toxicity. Benthic invertebrates are ideal bioindicators because: 1) they are abundant across a broad array of sediment types, 2) they are relatively sedentary, completing most or all of their life cycle in the same microhabitat, 3) they respond to the cumulative effects

of various stressors having differing magnitudes and periods of exposure, and 4) they integrate both the effects of stressors and the population compensatory mechanisms evolved over time to survive in a highly variable and potentially stressful environment.

Benthic invertebrate community samples will be collected from the sample locations identified on Figure 5 as Site Triad stations and reference Triad stations. As indicated, the location of these stations is tentative and will be finalized after a reconnaissance study. Benthic invertebrate community sampling is described in detail in SOP 240 in the FSP. Lab procedures for analysis of benthic community samples are described in SOP 350.

#### ***2.5.4.4 Sampling Equipment***

Sampling equipment needed to collect the samples includes a boat, Ponar sampler or coring device, sample containers, and appropriate PPE as required by the HSP. A comprehensive list of sampling equipment is listed in SOP 240.

#### ***2.5.4.5 Sample Collection***

All details regarding sample collection will be recorded in the field logbook. Samples will be collected using either a Ponar sampler, Ekman dredge, or coring device. Sediment will be collected from the bioactive zone, defined as the upper four inches of the sediment column. Procedures for sediment sampling for benthic community analysis are described in SOP 240.

#### ***2.5.4.6 Sample Handling and Analysis***

Proper field sampling documentation and field analytical and laboratory documentation helps to ensure sample authenticity and data integrity. Section 3.2 of this FSP describes the methods for assigning unique sample names. The unique sample name will be used for the sample containers and chain of custody. Procedures for sample shipping are described in SOP 210. Analyses required for the samples are listed on Table 1. The laboratory providing analytical services will be identified later.

### **2.5.5 Sediment Toxicity Testing**

A 28-day *Hyaella azteca* toxicity will be conducted to supplement the previous bioassay studies using Site sediments (SEH 2001). In addition, if necessary, 28-day bioassays with *Chironomous tentans* assay will also be conducted. Bioassay stations will be co-located with the benthic community stations.

#### **2.5.5.1 Sample Location and Frequency**

One composite sediment sample from the top 10cm of the sediment column will be collected from each of the eight benthic sampling locations in the contaminated area and from each of the four reference station areas. The sample and reference locations are shown on Figure 5.

#### **2.5.5.2 Sample Collection Procedures**

Sediment samples to be used for sediment toxicity testing will be collected as described in SOP 240.

## **2.6 FISH TISSUE SAMPLES**

NSPW proposes to implement the Work Plan developed by SEH for collection of fish tissue for supporting a baseline human health and ecological risk assessment. One of the target species has been predetermined, the smelt, and the other two will be selected from a list commonly consumed by recreational anglers and subsistence fisherman.

Smelt already have been sampled during the 2004 seasonal run and the data will be incorporated into the RI Report. The results from smelt sampling results will be used for both the ecological and the human health risk assessment as the fish were appropriately sampled and processed for these purposes.

The SEH Work Plan proposed that two other species from the following list will also be collected:

- Walleye
- Lake trout

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- Round Whitefish

The Chippewa Nation has indicated that it is primarily concerned with sedentary (sic) top-order predators such as: yellow perch, northern pike, smallmouth bass, and walleye so they will also be added to the list of possible species.

Order of preference for fish species will be:

- Walleye
- Northern Pike
- Yellow perch
- Smallmouth bass
- Lake trout
- Round Whitefish

#### **2.6.1 Sample Location and Frequency**

Sixteen fish of each species will be collected by electroshocking from the Site area and a reference area selected after discussion with WDNR fisheries staff. (Note that USEPA advises that the near shore area between Fish and Terwilleger Creeks is an acceptable reference area). Sampling and laboratory processing methodology are similar to those proposed by SEH (2003) and are described in detail in SOP 230 of the FSP. A total of sixteen fish of each species will be collected; eight will be filleted and data from those used to support the human health risk assessment and eight will be collected for supporting the ecological risk assessment. In addition, all fish caught will be examined and morphological abnormalities including tumors, noted.

Fish collection of a target species should occur during the normal fishing season for Lake Superior Waters as described in the current Wisconsin Fishing Regulations, if practicable.

##### **2.6.1.1 Sampling Equipment**

Sampling equipment needed to collect fish tissue samples includes a boat, collection equipment, sample containers, and appropriate PPE. A comprehensive list of sampling equipment is listed in SOP 230.



### **2.6.1.2 Sample Collection**

All details regarding fish tissue sample collection will be recorded in the field logbook. Additionally, sample information will be recorded on the field record form. Three species of fish will be selected for tissue sample collection, smelt, and two higher trophic level species. Smelt will be collected using seine nets. The other species will be collected using a boat-mounted electrofishing unit. Procedures for fish tissue sample collection are described in SOP 230.

### **2.6.2 Sample Handling and Analysis**

Proper field sampling documentation and field analytical and laboratory documentation helps to ensure sample authenticity and data integrity. Section 4.2 of this FSP describes the methods for assigning unique sample names. The unique sample name will be used for the sample containers and chain of custody. Procedures for sample shipping are described in SOP 210. Analyses required for fish tissue samples are listed on Table 1. The laboratory providing fish tissue analytical services will be identified later.

## **2.7 SURFACE WATER QUALITY INVESTIGATION**

Surface water sampling will be conducted to provide information for the Baseline Ecological Risk Assessment and the Human Health Risk Assessment. The results of this work task will be used to address the following questions:

1. What contaminants present in the surface water over the Site that may have originated from the contaminated sediment?
2. Are contaminants in the surface water potentially affecting human health or the environment?
3. Under what conditions do contaminants associated with the sediment get re-suspended? Information from this task as well as the sediment stability work tasks will be used to address this question.

### **2.7.1 Sample Location and Frequency**

#### **2.7.1.1 Ecological Risk Assessment Samples**

Surface water samples will be collected on two separate occasions from six Site locations on a transect extending from the shoreline offshore beyond the area of impacted sediment (Figure 6).

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In addition two reference stations will be sampled. Samples will be collected once when the water is calm and once following a high energy event within 24 hours of a period following a period when waves exceeded 30cm. At each station a near bottom station and at mid water column sample will be collected. Samples collected to support the BERA will be split and one fraction filtered (0.45  $\mu$ m filter). Both the filtered and unfiltered fractions will be analyzed for PAHs, VOCs and dissolved organic matter (DOC).

#### **2.7.1.2 Human Health Risk Assessment Samples**

Surface water samples will be collected along a shoreline transect at six separate locations at the Site in water two to three feet deep (Figure 6). In addition two reference stations will be sampled. Samples will be collected once when the water is calm and once following a high energy event within 24 hours of a period following a period when waves exceeded 30cm. At each station a mid water column sample will be collected. Unfiltered samples will be analyzed for PAHs, VOCs and dissolved organic matter (DOC).

#### **2.7.2 Surface Water Sample Collection Procedures**

Surface water sampling will follow procedures outlined in SOP 310 in the FSP which is similar to the USEPA ERT SOP #2013 (<http://www.ertresponse.com/sops/2013-r10.pdf>). Water samples will be collected using a discrete depth sampler such as a Kemmerer or Van Dorn-type sample bottle or using a pump.

At the time of sample collection field measurements of temperature, conductivity and dissolved oxygen will also be made at all stations.

#### **2.7.3 Sample Handling and Analysis**

Proper field sampling documentation and field analytical and laboratory documentation helps to ensure sample authenticity and data integrity. Section 3.2 of this FSP describes the methods for assigning unique sample names. The unique sample name will be used for the sample containers and chain of custody. Procedures for sample shipping are described in SOP 210. Analyses required for surface samples are listed on Table 1. A complete list of analytes is shown on Table 2. Northern Lake Service, of Crandon, Wisconsin will provide surface water analytical services.

## **2.8 SEDIMENT STABILITY INVESTIGATION**

### **2.8.1 Sample Location and Frequency**

The field program required to collect the data needed for sediment stability analysis consists of:

- Sediment cores for determining erosion characteristics
- A tripod deployment for measuring waves and currents
- Soil borings and sediment cores for developing high-resolution vertical profiles of sediment characteristics

A review of existing data available (SEH 1998, 2002) indicates that cohesive characteristics may occur. As discussed previously, the erosional characteristics of cohesive sediments are very site-specific, and there is little guidance available for developing the erosion characteristics of cohesive sediments from bulk sediment properties. The best method is to use in-situ erosion testing.

#### **2.8.1.1 Erosion Testing**

Approximately five sediment cores will be collected for use in Sedflume erosion testing. The core locations will be distributed across the offshore site (Figure 7) to cover possible variations in sediment characteristics and related erosion properties, (i.e. mineral substrate, mixed mineral and wood debris, and primarily wood debris). These locations will be selected after the reconnaissance study described in Section 4.3.3.4.2 of the Rev. 02 RI/FS Workplan. The cores will be collected as described further in SOP 290, packaged and shipped as described in SOP 210 to a designated laboratory for erosion testing. A sub-work plan for Sedflume Testing is included in Appendix C.

The purpose of collecting five cores is not meant to fully characterize all sediment properties throughout the sediment area, but to develop an understanding of representative erosion characteristics and their variability. The data from the core sampling and erosion testing will provide critical thresholds for erosion and the erosion rate vs. applied stress curve.

#### **2.8.1.2 Current Wave Measurements**

A one-month tripod deployment will be made to provide vertical profiles of the velocities and suspended sediments in the wave/current boundary layer. The tripod will be centrally located in the affected area (Figure 7) and outfitted with a downward looking Acoustic Doppler Current Meter

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(ADCP) and pressure transducer for the purpose of obtaining detailed vertical profiles of wave and current speeds and wave heights.

The system will be configured to record signals at 10 Hz or higher for two-minute bursts every two hours for the duration of the deployment. The recorded data will be reviewed after a one-month period to ensure that a sufficient range of wave and current conditions occurred. If not, then the deployment will continue until sufficient data is collected.

Procedures for placing and servicing the ADCP are described in SOP 280.

### **2.8.1.3 Age Dating**

Six offshore cores will be obtained for use in  $Pb_{210}$  and  $Cs_{137}$  age-dating analysis and developing high-resolution vertical profiles of grain size, mineralogy, and chemistry. The six core locations will be located to assess variations in the vertical profile properties with water depth and proximately to the WWTP. One core will be located further offshore as a control point. The tentative locations for these borings are depicted in Figure 5. The selection of the core location will be finalized in the field. The cores will be sub-sampled at 2 centimeter intervals in accordance with SOP 290 and subdivided into sections for the various analyses. In addition to conducting  $Pb_{210}$  and  $Cs_{137}$  age-dating analysis (SOP 340), all intervals will be analyzed for grain size (ASTM D422) mineral content and total PAHs.

## **2.8.2 Sediment Stability Sample Collection Procedures**

### **2.8.2.1 Sampling Equipment**

Sampling equipment needed to collect the samples includes a boat, Ponar sampler or coring device, and sample containers. A comprehensive list of sampling equipment is listed in SOP 290.

### **2.8.2.2 Sample Collection**

All details regarding sample collection will be recorded in the field logbook. Samples will be collected using with a coring device or vibracore using procedures described in SOP 290.

### **2.8.2.3 Sample Handling and Analysis**

Proper field sampling documentation and field analytical and laboratory documentation helps to ensure sample authenticity and data integrity. Section 4.2 of this FSP describes the methods for assigning unique sample names. The unique sample name will be used for the sample containers and chain of custody. Procedures for sample shipping are described in SOP 210. Analyses required for the samples are listed on Table 1. The laboratory providing analytical services will be identified later.

## **2.9 PORE WATER INVESTIGATION**

Pore water samples will be collected to evaluate the relationship between contaminants present in Chequamegon Bay and the shallow aquifer in Kreher Park. This investigation will be completed by deploying passive diffusion bag (PDB) samplers in six shallow temporary wells. A typical PDB sampler consists of a low-density polyethylene (LDPE) lay-flat tube closed at both ends containing deionized water. The sampler is positioned at the target horizon of the well by attachment to a weighted line or fixed pipe. Horizontal flow through the well will cause the deionized water in the PDB to equilibrate with contaminants present in the aquifer. Following an equilibration period of one month, the PDB is removed from the well, the contents are placed in laboratory containers and submitted for VOC analysis. The sample results will be used to identify contaminant migration trends between the Bay sediment and shallow groundwater in Kreher Park.

### **2.9.1 Sample Location and Frequency**

Pore water samples will be collected from six temporary wells installed along two transects at Kreher Park. The transects will be located near the Chequamegon Bay inlet west of the former POTW, each consisting of three temporary wells. The first transect will originate from immediately south of the concrete rip-rap along the shoreline, approximately 110 feet east of MW-24 and extend towards the former solid waste disposal area (landfill). The second transect will originate from immediately south of the concrete rip-rap along the shoreline, approximately 60 feet east of MW-25 and extend towards the former coal tar dump. The temporary wells will be spaced approximately 25 feet apart. The proposed temporary well locations are shown on Figure 4. Pore water samples will be submitted for analysis of VOCs as shown on Table 2. Pore water samples will be collected once from each temporary well. Following this single sampling

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event, the temporary wells will be abandoned. All pore water samples will be collected in accordance with SOP 300.

### **2.9.2 Temporary Well Installation**

The PDBs will be deployed in temporary monitoring wells. These temporary wells will be installed in a borehole advanced with a hollow stem auger to a maximum depth of 1.5 feet below the water table, approximately four feet below the ground surface at Kreher Park. Well casing and screens will be flush-threaded 2-inch diameter schedule 40 PVC. The wells will have a two-foot screen with a slot size of 0.010 inches. The borehole annulus will be filled with filter pack sand to a maximum of 6 inches above the screened interval. A 6 inch layer of bentonite granules will be placed above the filter pack. A flush mount protective cover will be installed at each well location to prevent unauthorized access to the monitoring wells. Following the sampling event, each temporary well will be abandoned in accordance with WAC ch. NR 141 requirements. Procedures for temporary well installation are described in SOP 300. Procedures for well abandonment are described in SOP 120.

### **2.9.3 Sample Collection Procedures**

#### **2.9.3.1 Sampling Equipment**

Sampling equipment needed to collect pore water samples includes PDB vessels, weights and cable, deionized water (supplied by the laboratory), laboratory bottles, and appropriate PPE as required by the HSP. A comprehensive list of equipment is listed in SOP 300.

#### **2.9.3.2 Sample Collection Procedures**

All details regarding pore water sample collection will be recorded in the field logbook. Procedures for pore water sample collection are described in SOP 300. Prior to deployment, fill the PDB with deionized water to its maximum capacity. There should not be voids or pockets of air. Inspect the unit for leaks or damage. Attach the weight to the bottom of the PDB and attach a cable to the top of the PDB. Lower the PDB into the well below the water surface. Secure the cable to the well cap. The cable should be of sufficient length so the PDB is located in the screened interval below water when the cap is replaced. Secure well cap on top of well and replace flush mount cover. Allow one month for the PDB to equilibrate with the pore water.

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Following the stabilization period, gently remove the PDB and rinse the exterior with deionized water. Transfer the contents of the PDB to laboratory containers and place in a cooler with ice. Fill out chain-of-custody forms and prepare cooler for shipping according to the laboratory's instructions.

### **2.9.3.3 Sample Handling and Analysis**

Proper field sampling documentation and field analytical and laboratory documentation helps to ensure sample authenticity and data integrity. Section 3.2 of this FSP describes the methods for assigning unique sample names. The unique sample name will be used for the sample containers and chain of custody. Procedures for sample shipping are described in SOP 210. Analyses required for pore water samples are listed on Table 1. A complete list of analytes is shown on Table 2. Northern Lake Service, of Crandon, Wisconsin will provide pore water analytical services.

## **2.10 SOIL VAPOR INVESTIGATION**

### **2.10.1 Sample Location and Frequency**

Soil gas vapor samples will be collected from nine vapor probes that will be installed at the following locations:

- From vapor monitoring probe VP-1 installed in the filled ravine area east of the NSPW administration building near the southeast corner of the asphalt parking lot;
- From vapor monitoring probes VP-2S and VP-2D installed in the filled ravine south of and along St. Clair Street, north of the paved courtyard area;
- From vapor monitoring probes VP-3S, VP-3I, and VP-3D installed near well MW-2R in the NSPW storage yard north of St. Claire Street; and
- From vapor monitoring probes VP-4 VP-5, VP-6 and VP-7, which will be installed east of the edge of the filled ravine and north of St. Claire Street. These vapor monitoring will evaluate soil vapors for potential impacts from groundwater in the vicinity of residences near the former MGP. VP-5 and VP-6 will be installed in the unsaturated zone of the Miller Creek formation. VP-7 and VP-8 will be installed in the backfill of sewer lines (to the extent practical) to evaluate the potential migration of vapors in the backfill of these utility conduits

- From vapor monitoring probes VP-8 and VP-9 will be installed on the west side of 3<sup>rd</sup> Street directly across 3<sup>rd</sup> Street from the former gas holder that was located in the southwest corner of the existing facility building.

At two locations on NSPW property, a nest of up to three vapor probes will be installed (at shallow, intermediate, and deep intervals). Two of these probes (VP-2 and VP-3) will be directly above the most contaminated areas of the filled ravine. Soil vapor samples from these two probe nests will likely be sufficient to evaluate the worst-case soil vapor. The remaining vapor probes (VP-1, VP-4, VP-5, VP-6, VP-7, VP-8 and VP-9) are located outside the groundwater contaminant plume in the uppermost water bearing unit, but within the footprint of groundwater contaminant plume of the underlying Copper Falls aquifer.

Two rounds of soil vapor samples will be collected from each location will assist with the evaluation of potential vapor migration from areas of known contamination. The first round of soil vapor samples will be collected a minimum of one week following vapor probe installation. Assuming the first round is collected during the spring, summer, or fall, the second round of soil vapor sampling will be collected during the winter months (frozen conditions). Grab samples will be collected from soil vapor probes located at the Site. Prior to collection of the soil vapor samples, probes will be purged of standing vapors. Soil vapor samples will be analyzed for TO-15A parameters. The sample locations are shown on Figure 2. The soil vapor samples will be collected in accordance with SOP 200.

## **2.10.2 Sample Collection Procedures**

### **2.10.2.1 Soil Vapor Probe Installation**

Vapor monitoring probes will be installed in shallow soil borings advanced with a Geoprobe drill rig. Each probe will consist of a Geoprobe implant and small diameter tubing encased in a flush mount well casing cemented in place. Geoprobe implants are small diameter (1/4 – 3/8-inch) wire screens constructed of double woven stainless steel. Implants will be installed by advancing the drill rod to the target depth, inserting the implant through the drill rod. The implant is then connected to a drive point on the lead drill rod. When the drill rod is pulled back, the implant is anchored in place by the drive point. Implants 6-inches in length will be installed with 12-inches of fine sand placed around the implant. Granular bentonite will be used to



backfill the borehole annular space seal above the sand pack. Vapor probes will be installed in accordance with SOP 200.

Implants will be installed in the unsaturated zone at shallow, intermediate, and deep intervals. Implants installed at the deep interval will be installed approximately one foot above the saturated zone to evaluate the migration of soil vapors from groundwater. Shallow interval implants will be installed in native soil approximately 2-feet below ground surface to evaluate the migration of vapors to the surface. An implant will be installed at an intermediate interval at locations where the unsaturated zone is thicker than 10 feet. At the VP-1 VP-4, VP-5, VP-6, VP-7, VP-8, and VP-9 locations, implants will be installed at shallow intervals between 1 and 2 feet below ground surface to evaluate the migration of vapors from known areas of contamination. (VP-1 is located in the filled ravine, but up gradient from the MGP facility. VP-4 VP-5, VP-6, and VP-7 are located on the north side of St. Claire Street. VP-8 and VP-9 are west of 3<sup>rd</sup> Avenue.) Because subsurface coal tar contamination is present at the VP-2 and VP-3 locations, implants will also be placed at multiple intervals at these locations. At the VP-2 location, the unsaturated zone is approximately 5-feet thick. (Groundwater has historically been encountered at an approximate depth of 5 feet in well TW-13). The implant for VP-2S will be installed between 1 and 2 feet bgs, and the implant for VP-2D will be installed between 3 and 4 feet bgs. At the VP-3 location, the unsaturated zone is approximately 15-feet thick. (Groundwater has historically been encountered at an approximate depth of 15 feet in well MW-2R). The implant for VP-2S will be installed between 1 and 2 feet bgs, and the implant for VP-2D will be installed between 13 and 14 feet bgs. The implant for VP-3I will be installed between 1 and 2 feet bgs, and the implant for VP-2D will be installed between 6 and 7 feet bgs.

#### **2.10.2.2 Sampling Equipment**

Sampling equipment needed to collect soil vapor samples includes 6 L passivated Summa canisters, Teflon tubing and inline particulate filters. A comprehensive list of equipment needed is listed on SOP 200.

#### **2.10.2.3 Sample Collection**

All details regarding soil vapor sample collection will be recorded in the field logbook. Additionally, sample information will be recorded on the canister sampling collection form. The soil vapor sample is a grab sample and does not require the use of a regulator. The valve cap on

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the Summa canister is removed and the particulate filter is then connected inline to the valve stem. Teflon tubing is used to connect the particulate filter to the vapor probe wellhead. The canister valve is opened and allowed to fill. The canister should equilibrate within one to two minutes (no audible sound of rushing gas). Once the canister has equilibrated, the canister valve is closed and the valve cap replaced. Procedures for soil vapor sample collection are described in SOP 200.

#### **2.10.2.4 Sample Handling and Analysis**

Once collection of the soil vapor sample is complete and the cap is replaced on the canister valve, a canister tag will be filled out and attached to the canister. The tag will detail the sample ID and other pertinent information. The canister will be shipped to the laboratory in the same packaging as it was shipped. A laboratory chain of custody will be filled out and accompany the samples during shipment. The hold time for TO-15A analysis is 30 days.

For this RI, the soil vapor samples will be analyzed for VOCs using method TO-15. A list of analytes for the TO-15A analysis is listed in Table 3. Severn Trent Laboratory of Knoxville, Tennessee will perform soil vapor analytical services.

### **2.11 INDOOR AIR VAPOR INVESTIGATION**

#### **2.11.1 Sample Location and Frequency**

In addition to the collection of air samples from vapor probes, an indoor air sample will also be collected to evaluate the potential for vapor migration into the existing building, which overlies contamination in the backfilled ravine. The indoor air investigation will examine the constituents of indoor air and sub-slab soil vapors to determine if this area is being impacted by soil vapor migration and intrusion. Due to many other potential indoor and external sources of solvents, the results from indoor air sampling can be difficult to explain and unless accompanied by simultaneous soil vapor samples. It is optimal that soil vapor samples are collected from directly beneath the lowest slab of the building. It is preferred that subslab soil vapor samples be collected from at least two, opposite locations. Subslab soil vapor samples can demonstrate the presence of vapors directly beneath the building that may be entering through cracks, sumps, exposed soils or other locations. If a subslab soil vapor sample is not practical, then the next

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acceptable location for soil vapor sampling is from a soil vapor probe located as close as possible to the edge of the building foundation, preferentially inserted at an oblique angle, so as to collect a soil vapor sample that is best representative of conditions *beneath* the foundation.

Indoor air sample collection will include the collection of indoor air samples and a subslab vapor samples. The indoor air samples will be collected from inside the NSPW Service Center building near the former gas holder located near MW-15. The subslab vapor sample will be collected from a probe installed beneath the floor in this same area. Two rounds of samples will be collected; one round will be collected during the winter months when the ground is frozen, and the other round will be collected in the spring, summer, or fall when the ground is unfrozen. An ambient air sample will be collected simultaneously with the collection of each round of indoor air/subslab vapor samples and the collection of soil vapor samples from each soil vapor probe location.

The ambient air sample will be collected at a location upwind of the buildings being investigated from locations that are not impacted by potential airborne releases from the Ashland/NSP Lakefront site and other nearby, unrelated sources (such as gas stations on Highway 2). This background sample location can be either on- or off-site, but should be selected using professional judgment and based on locations not likely to be adversely impacted by potential releases from nearby sources, both site and non-site related. Additionally, the selection of background ambient air sample locations must take into account current and forecasted weather conditions.

Prior to collecting the indoor air/subslab vapor sample in each home, background conditions affecting indoor air quality will be evaluated. This evaluation will include the following steps:

**Step 1** Inspect the sample location area to identify consumer products (e.g. cleaners, paints, or glues) that may contribute to increased indoor air concentrations absent any subsurface contribution.

**Step 2** Complete an occupant survey to identify occupant activities (e.g. smoking, welding, or operations of small engines, gasoline power tools, or fleet vehicles) that may contribute to increased indoor air concentrations absent any subsurface contribution.

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**Step 3** Remove or prevent use of all potential sources that may contribute to increased indoor air concentrations absent any subsurface contribution for a minimum of 24 hours before sample collection.

**Step 4** Collect an ambient (outdoor) air sample in conjunction with the indoor air sample.

All air and background samples will be analyzed for VOCs by Method TO15A. All samples will be collected in evacuated summa canisters provided by the laboratory, and shipped via overnight courier to the laboratory. Summa canisters are shipped from the laboratory under negative pressure; when the valve on the canister is opened air is drawn into the canister. A regulator will be used to collect the indoor air sample over a 24 hour period; the background sample will be collected over a one-hour period. Grab samples will be collected from the vapor probes by connecting the canister to the tubing, and opening the valve. These canisters will be filled in less than one minute. Air samples will be collected in accordance with SOPs included in the FSP.

## **2.11.2 Indoor Air Vapor Sample Collection Procedures**

### **2.11.2.1 Sampling Equipment**

Sampling equipment needed to collect indoor air vapor samples includes 6 L passivated Summa canisters, 24 hour regulators, and inline particulate filters. A comprehensive list of equipment needed is listed on SOP 200.

### **2.11.2.2 Sample Collection**

All details regarding indoor air vapor sample collection will be recorded in the field logbook. Additionally, sample information will be recorded on the canister sampling collection form. The sample will be collected over a period of 24 hours using a regulator. The regulator is used to provide a time weighted average (TWA) sample by restricting the flow rate of air entering the canister. The valve cap on the Summa canister is removed and the regulator is connected to the valve. A particulate filter is then connected inline to the regulator. The canister valve is then opened and the start time recorded in the field logbook. For the indoor air vapor samples, a sample interval of approximately 24 hours is required. Once 24 hours has passed, the canister valve is closed and the valve cap replaced. The end time will then be recorded in the field logbook. Procedures for indoor air vapor sample collection are described in SOP 200.

### **2.11.2.3 Sample Handling and Analysis**

Once collection of the indoor air vapor sample is complete and the cap is replaced on the canister valve, a canister tag will be filled out detailing the sample ID, sample duration, regulator type and other pertinent information. This tag is then attached to the canister. The canister will be shipped to the laboratory in the same packaging as it was shipped. A laboratory chain of custody will be filled out and accompany the sample during shipment. The hold time for TO-15A analysis is 30 days.

For this RI, the indoor air vapor samples will be analyzed for VOCs using method TO-15A. A list of analytes for the TO-15A analysis is listed in Table 3. Severn Trent Laboratory of Knoxville, Tennessee will perform analytical services.

## **2.12 EXPLORATION TEST PITS**

### **2.12.1 Sample Location and Frequency**

Exploration test pits will be excavated at Kreher Park to further characterize the limits of fill for the solid waste disposal and the former coal tar dump areas. Two test pits will be excavated on each side of the former solid waste disposal area (eight total), and two test pits will be excavated across a former open sewer in this area. Test pits will also be excavated in the vicinity of the former coal tar dump to determine the lateral extent of contamination in this area. Two test pits will be excavated on the east and west sides, two in the center, one on the north side, and one on the south side of the former coal tar dump area (eight total). Additionally, three test pits will be excavated across former drainage ditches/culverts. As shown on Figure 3, a former open sewer drainage swale is located in the solid waste disposal area, and a former culvert/trench is located beneath the southwest corner of the waste water treatment plant north of the former coal tar dump, and a trench is located east of the former treatment plant. Proposed test pit locations are also shown on Figure 12.

Each test pit will be excavated to a depth between 6 and 8 feet. Material encountered in each test pit will be visually described, and photographed as needed. Test pits will be terminated when the limits of fill have been determined, or until obstructions or caving prevent additional excavation. Material removed from the test pits will be returned to the excavation. In the event that coal tar is encountered in test pits, a grab sample will be collected and submitted to Batelle Laboratories for fingerprint analysis. Additionally, surface soil samples will be collected at each test pit location as described in Section 2.2 of this FSP.

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### **2.12.2 Exploration Test Pit Sample Collection Procedures**

A test pit is an opening in soil, unconsolidated deposit, or bedrock having at least one lateral dimension greater than the depth of the opening, which is used for scientific purposes. The location of each test pit shall be coordinated in writing with the City of Ashland before digging begins. The contractor shall follow Occupational Safety and Health Administration (OSHA) rules for excavation and confined space entry. The excavated material shall be screened for hazardous properties. Nonhazardous excavated material shall be backfilled immediately after the required information has been recorded. The first soils out shall be the last in when filling the pit. No test pit shall be left open overnight unless adequate safety precautions are employed. In the event that a test pit must remain open overnight, an exclusion zone consisting of construction fencing will be secured to prevent access. In vegetated areas, backfilled test pits shall be restored with seed and straw mulch. In addition to the general information required for all field activities listed in Section 4.1, the following shall be recorded for each test pit:

1. The total depth, length, and width;
2. The depth and thickness of distinct soil or lithologic units;
3. A lithologic description of each unit;
4. A description of any man-made materials or apparent contamination encountered;
5. A sketch of the test pit; and
6. Photographs of the excavation.

Excavation shall occur by using either a backhoe or hand shovel. Decontamination of all equipment shall occur after an excavation is completed or daily following the procedures described in Section 5.0. Any shoring that is required shall be described and documented.

#### **2.12.2.1 Sampling Equipment**

One grab sample of will be collected from the test pit using hand tools (spoons, trowels, and/or shovels), clean spatulas, and sample containers. Appropriate PPE, as required by the HSP, will also be used.

#### **2.12.2.2 Sample Collection**

Soil samples will be collected directly from the excavator bucket after removal from the excavation or from the soil stockpile. Procedures for soil sample collection are described in SOP 140.

#### **2.12.2.3 Sample Containerization**

Soil samples collected from the test pits will be placed in appropriate laboratory supplied containers. Samples be placed in containers and preserved in accordance with the analytical requirements listed in Table 1. Procedures for filling laboratory containers are described in SOP 160.

#### **2.12.2.4 Sample Handling and Analysis**

Proper field sampling documentation and field analytical and laboratory documentation helps to ensure sample authenticity and data integrity. Section 4.2 of this FSP describes the methods for assigning unique sample names. The unique sample name will be used for the sample containers and chain of custody. Procedures for sample shipping are described in SOP 210. Soil samples collected from test pits will be submitted to Battelle Laboratories for fingerprint analysis.

### **2.13 BOREHOLE GEOPHYSICAL SURVEY**

A borehole geophysical survey will be performed to verify subsurface geologic conditions. The geophysical survey will be conducted using a natural gamma survey and an induction log (electromagnetic conductivity) survey on wells MW-2BR/MW-2C located in the Upper Bluff Area and MW-2A (NET) located in Kreher Park.

Well casings for artesian wells AW-1 and AW-2 will also be visually inspected and recorded on videotape with the aid of a down-hole video camera. The purpose of this inspection is to:

- Determine the depth of the well;
- Determine the length and depth of the well screen; and
- Observe the condition of the well casing and screen.

Depending on the results of this camera survey, borehole geophysical surveys may also be completed on artesian wells AW-1 and AW-2. (If metal casing was used to construct wells AW-1 and AW-2, the borehole geophysical surveys will not be completed because the metal casing will interfere with the geophysical survey.) The borehole geophysical survey and visual inspection of the wells located in Kreher Park is contingent upon obtaining access from the City of Ashland. Fromm Applied Technology of Mequon, Wisconsin will perform the geophysical survey. The locations of these wells are shown in Figures 2 and 3.

#### **2.13.1 Geophysical Survey**

Borehole geophysics will be performed to verify subsurface geologic conditions. Fromm Applied Technology of Mequon, Wisconsin will perform the geophysical survey. The geophysical survey will be conducted using a natural gamma survey and an induction log (electromagnetic conductivity) survey on wells MW-2C, MW-2A (NET), AT-1 and AT-2. The geophysical survey of the wells located at Kreher Park is contingent on obtaining access from the City of Ashland.

#### **2.13.2 Video Logging**

A down-hole video camera will be used to visually inspect the well casings for the two artesian wells located at Kreher Park, AT-1 and AT-2. Fromm Applied Technology of Mequon, Wisconsin will perform video logging services. The purpose of this inspection is to:

- Determine the depth of the well;
- Determine the length and depth of the well screen; and
- Observe the condition of the well casing and screen.

This inspection is contingent on obtaining access to the wells from the City of Ashland. The visual inspection will be recorded on videotape.



## **2.14 QA/QC SAMPLES**

### **2.14.1 Replicate Samples**

Replicate samples include matrix spike and matrix spike duplicates (MS/MSD). One MS/MSD sample will be collected for every 20 investigative samples submitted for laboratory analysis and for every laboratory batch sample. The volume of groundwater collected at each of the locations where MS/MSD samples will be obtained will require double the sample volume for each organic and inorganic analysis. Soil sample volumes for VOC analysis will be sufficient to run MS/MSD analyses. No additional volume is required. One additional volume of soil will be required for all other chemical analyses. Section 4.2 of this FSP describes the methods for assigning unique sample names. The unique sample name will be used for the sample containers and chain of custody. Samples will be placed in laboratory-supplied containers and preserved in accordance with the analytical requirements listed in Table 1. Procedures for filling laboratory containers are described in SOP 160. Samples submitted for dissolved analytes will need to be field filtered prior to placement in containers. Procedures for field filtering are described in SOP 170.

### **2.14.2 Trip Blanks**

Trip blanks will be included with each shipping container that contains soil or groundwater samples to be analyzed for VOCs. Each trip blank for groundwater samples will consist of two 40 ml glass vials containing de-ionized water preserved with 1:1 HCl that has been prepared by the laboratory. Each trip blank for soil samples will consist of one 40 ml glass vial containing methanol (MeOH) that has been prepared by the laboratory. Section 4.2 of this FSP describes the methods for assigning unique sample names. The unique sample name will be used for the sample containers and chain of custody. One temperature blank will also be included with every shipping container from the laboratory.

### **2.14.3 Equipment Blanks**

Equipment blanks will be collected following decontamination of the soil sampling equipment (split spoon sampler, hand augers, knives). No equipment blanks associated with groundwater

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sampling will be collected since dedicated sampling equipment will be used for all sample locations.

One equipment blank will be collected for every 10 soil samples submitted to the laboratory with a minimum of one equipment blank per sampling crew per day. Following decontamination of the equipment, deionized water will be poured over selected sampling equipment and collected for laboratory analysis. The equipment blanks will be analyzed for the constituents of concern at the sample location where the equipment blank was obtained.

#### **2.14.4 Duplicate Samples**

Duplicate samples will be collected from selected soil and groundwater sample locations at a frequency of one sample for every 10 investigative samples submitted for laboratory analysis. Section 4.2 of this FSP describes the methods for assigning unique sample names. The unique sample name will be used for the sample containers and chain of custody. Samples will be placed in laboratory-supplied containers and preserved in accordance with the analytical requirements listed in Table 1. Procedures for filling laboratory containers are described in SOP 160. Samples submitted for dissolved analytes will need to be field filtered prior to placement in containers. Procedures for field filtering are described in SOP 170.

#### **2.14.5 Field Rinsate Blanks**

### **2.15 FIELD SURVEYING**

#### **2.15.1 Horizontal and Vertical Control**

All RI sample locations will be surveyed by a State of Wisconsin, Registered Land Surveyor. Nelson Surveying, Inc. of Ashland, Wisconsin will perform survey services at the Site. Horizontal control is based on Wisconsin State Plane – North datum. Elevation measurements are based on National Geodetic Vertical Datum (NGVD) 1929. This coordinate system will be used for establishing horizontal and vertical control to sampling data. For each monitoring well location, the top of the PVC well casing and the ground surface will be surveyed for horizontal and vertical control. For each soil sample, test pit, and vapor probe, the ground surface will be surveyed for horizontal and vertical control. The survey data will be entered into the Site GIS database, managed by Newfields.

### **2.15.2 Data Acquisition**

Surveying activities at the Site will be conducted by Nelson Surveying. A minimum of two control points will be established at the site upon which the State Plane coordinates and elevation are set. These points will be established in a permanent location where they will not be disturbed.

Measured elevations will be tied to existing Site control points, and referenced to NGVD29 elevations. Measured horizontal locations will be tied to the existing Site control points in the Wisconsin State Plane – North system. Horizontal orientation locations will be accurate to  $\pm 0.1$  feet and vertical orientation elevations accurate to  $\pm 0.01$  feet.

### **2.15.3 Historic Survey Data**

Historic sample locations have been surveyed based on an arbitrary coordinate system established by SEH during investigation activities completed for WDNR. The coordinate data associated with these historic samples will be converted to agree with the coordinate system established for this RI, described in Section 3.13.1.

### **3.0 SAMPLE DESIGNATION**

#### **3.1 LOGBOOKS**

Dedicated bound field logbooks will be maintained by each Field Manager. Entries will be described in as much detail as possible so that events can be reconstructed without reliance on memory. All entries in the logbook will be made with blue or black ink. Entries into the logbook will contain a variety of information regarding field activities at the Site. Each daily entry will begin with the following information:

- Date;
- Log open time;
- Title;
- Purpose and description of field activities;
- Weather;
- Field personnel; and
- Equipment used.

The sampling representative will date and sign each activity on the day completed. Corrections will be made by drawing a single line through the incorrect entry, entering the correct information, and initialize and dating the change. At the end of each day, the sampler or Field Manager will sign and enter the time after the last entry is made (log closed time).

All measurements made, photographs taken, and samples collected will be entered into the logbook. The logbook will contain a sufficient amount of information to distinguish each sample, photograph, or measurements from the others. That information will include:

- Project name;
- Unique, sequential field sample number;
- Matrix sampled;
- Description of physical properties of samples;
- Sample depth;
- Sampling date and time;

- Specific sample location in sufficient detail to allow re-sampling at the same location;
- Sampling methods and/or reasons for modifications to standard operating procedures;
- Preservation techniques, including filtration, as appropriate to sample type;
- Analyses to be performed;
- Significant observations made during the sampling process;
- Results of any field measurements;
- Photograph number, roll number, and photograph description;
- Printed name and signature of persons performing the field sampling; and
- Date and time of shipment, number of shipping containers, samples sent, and carrier.

Logbooks become a permanent part of the documentation for the project. At the completion of field activities, they will be delivered to the URS Project Director and will be placed in the project files maintained in the URS Appleton Office.

### 3.2 SAMPLE NOMENCLATURE

The sample numbering system for field sample collection will utilize a two-letter project identification code followed by a sample code and a location code. For this RI, the project location code will be NS (for NSP). The matrix code or sample type code will be an alpha code corresponding to the sample type as follows:

AA	Ambient Air	Indoor air vapor Samples
AQ	Air Quality Control Matrix	Background Air Samples
DC	Drill Cuttings	Soil Cuttings for Disposal
GS	Soil Gas	Soil Gas from Vapor Probes
GW	Groundwater	Groundwater Samples from Monitor Wells
SE	Sediment	Sediment Samples
SO	Soil	Surface/Subsurface Soil Samples
SQ	Soil/Solid Quality Control Matrix	Duplicate Soil samples
TA	Animal Tissue	Animal Tissue from Chequamegon Bay
TQ	Tissue Quality Control Matrix	Duplicate Tissue Samples
WP	Drinking Water	Water Samples from Artesian Wells
WQ	Water Quality Control Matrix	Duplicates, Field Blanks, and Trip Blanks
SW	Surface Water	Surface water samples from Chequamegon Bay

The location code will follow the sample type code and will consist of a two to five-digit numeric or alpha-numeric code that indicates the sample location. Location codes lower than 10 will be preceded by a '0' (e.g. 01, 02, etc.). For groundwater samples, the location code will be the monitoring well number. Geoprobe soil samples, surface soil samples, field blanks, and trip blanks will use a consecutive numbering system. For subsurface soil samples, the location code will be followed by the depth of the sample. Samples collected from one location more than one time (e.g. quarterly groundwater samples, soil gas samples) will have a date code following the location code. The date code will consist of four numbers, a two number month and two number year corresponding to the month and year the sample is collected. Examples of sample identification numbers would be:

- NS-GWMW10-0304, for NSP site, groundwater sample from monitoring well MW-10 in March 2004.
- NS-WQMW02C-0304-MS/MSD, for NSP site, groundwater matrix spike/matrix spike duplicate from piezometer MW-2C in March 2004.
- NS-SOGP01-2-4, for NSP site, subsurface soil sample from Geoprobe Boring 01 at a depth of 2-4 feet below ground surface (bgs)
- NS-SOSS03, for NSP site, surface soil sample from location number 3
- NS-WQTripBlank01-0304, for an aqueous trip blank submitted on the first day of groundwater sampling in March 2004.
- NS-WQDUP01-0304, for aqueous field duplicate sample number one in March 2004.

### **3.3 SAMPLE SHIPPING**

Environmental samples will be shipped via an overnight courier service (e.g. UPS), with delivery specified for the following morning. The field manager should contact the laboratory ahead of time to inform laboratory personnel of the number of samples, analytes, courier service, and other pertinent information to ensure the integrity of sample results. Samples will be shipped in a manner to guarantee delivery to the laboratory before hold times expire. Analytes that have specific temperature requirements (i.e. 4° C) will be shipped in a cooler with ice. All shipping procedures will comply with DOT regulations (49 CFR 173 to 177) and the International Air Transportation Association (IATA). Procedures for shipping environmental samples are detailed in SOP 210.

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Whenever possible, samples from discreet locations will be shipped in the same cooler or package. Sample containers should be placed upright and packed in a manner to prevent breakage. When ice is used, it should be double bagged to prevent leakage and placed on top of the sample jars. Any voids remaining in the cooler should be filled with cushioning materials. The chain of custody will be placed in a waterproof plastic bag and taped to the interior lid of the cooler.

The lid of the cooler or package will be secured by a two to three wraps of strapping tape in a minimum of two locations. A numbered custody seal will be placed spanning the lid and body of the cooler and covered with clear tape. The shipping label will be attached to the top of the package.

The analytical laboratories' addresses and Site Project Managers are as follows:

Northern Lake Service, Inc  
400 North Lake Avenue  
Crandon, Wisconsin 54520  
Phone: (715) 478-2777  
Contact: Mr. Steve Mlejnek

STL Knoxville  
5815 Middlebrook Pike  
Knoxville, Tennessee 37921  
Phone: (865) 291-3000  
Contact: Ms. Jaime McKinney

## **4.0 DECONTAMINATION**

### **4.1 STANDARD PROCEDURES**

A decontamination area for sample preparation equipment will be established within or near the boundary of the Exclusion Zone (EZ). The EZ is defined as the area where contamination is either known or likely to be present, or because of activity, will potentially harm personnel. Entry into the EZ requires the use of personal protective equipment.

A personnel decontamination station will be established outside and adjacent to the EZ. All personnel will proceed through the appropriate contamination reduction sequence upon leaving the EZ. All personal protective equipment will be left on-site during any breaks after performing decontamination procedures.

### **4.2 DECONTAMINATION OF EQUIPMENT**

To maintain clean working conditions and control the quality of the collected samples, proper equipment decontamination procedures will be followed during all field activities. For groundwater sampling, dedicated or disposable sampling equipment will be used whenever possible to minimize the potential for cross-contamination. Decontamination procedures will be performed in accordance with SOP 190. Heavy equipment decontamination procedures are outlined in SOP 220. Decontamination activities will be documented in the field logbook.

#### **4.2.1 Sampling Equipment**

Sampling equipment requires special cleaning. Decontamination of all sampling equipment will be performed in accordance with the following procedure:

- Wash the equipment with a solution of Alconox and potable water. Additionally, circulate the solution through non-dedicated equipment, such as submersible pumps.
- Triple rinse the equipment with distilled water, allow to air dry.



#### **4.2.2 Tools**

Tools used during sample preparation (i.e. mixing bowls, hand augers, split spoons, and spatulas) will be decontaminated in accordance with the following procedure:

- Remove all soil by scrubbing with a mixture of Alconox and potable water.
- Rinse with potable water.
- Triple rinse with distilled water

#### **4.2.3 Respirators**

Certain parts of respirators, such as the harness assembly and cloth components are difficult to decontaminate. If grossly contaminated, they will be discarded. Rubber components can be soaked in soap and water and scrubbed with a brush. Individual owners of respirators are responsible for decontaminating and maintaining their own respirators.

#### **4.2.4 Sanitizing Personal Protective Equipment**

Respirators, reusable protective clothing, and other personal articles not only must be decontaminated before being reused, but also must be sanitized. The inside of masks and clothing becomes soiled because of exhalation, body oils, and perspirations. The manufacturer's instructions will be followed to sanitize the respirator mask. If practical, protective clothing will be machine washed after a thorough decontamination, otherwise, it will be cleaned by hand.

#### **4.2.5 Heavy Equipment**

Drill rigs and other heavy equipment are difficult to decontaminate. Generally, they are steam cleaned with water under high pressure and/or accessible parts are scrubbed with detergent/water solution under pressure, if possible. Particular care must be given to those components in direct contact with contaminants, such as tires, augers, or buckets. Before leaving the site, all heavy equipment will be inspected by the Field Manager to confirm the decontamination effort.

#### **4.3 PERSISTENT CONTAMINATION**

In some instances, clothing and equipment will become contaminated with substances that cannot be removed by normal decontamination procedures. A strong detergent (industrial grade) may be used to remove such contamination from equipment if it does not destroy or degrade the protective material. If persistent contamination is expected, disposable garments will be used.

#### **4.4 DISPOSAL OF CONTAMINATED MATERIALS**

All disposable and/or single-use materials and equipment used for decontamination must be disposed of properly. Clothing, tools, buckets, brushes, and all other equipment that is contaminated must be secured in drums or other containers and labeled. Clothing not completely decontaminated on-site will be secured in plastic bags before being removed from the site. Contaminated wash and rinse solutions will be contained and spent solutions will be disposed at the on-site treatment system.

#### **4.5 MINIMAL DECONTAMINATION**

Less extensive procedures for decontamination can be established when disposable clothing and equipment are used, the type and degree of contamination become known, or the potential for transfer is judged to be minimal by the Site Health and Safety Officer in consultation with the Project Manager.

## **5.0 INVESTIGATIVE DERIVED WASTE MANAGEMENT PLAN**

Investigative derived wastes (IDW) will be generated during several phases of the RI at the Site. This section presents the methodology to be utilized for the storage and disposal of the wastes. Each investigative waste stream will require specific handling, storage and disposal procedures to ensure that potential adverse environmental impacts associated with the waste does not occur, and that all wastes are characterized and disposed in accordance with the provisions set forth in NR 600 of the Wisconsin Administrative Code and 40 CFR 261 of the Code of Federal of Regulations.

### **5.1 IDENTIFICATION OF INVESTIGATIVE DERIVED WASTE STREAMS**

Four sources of investigative derived waste have been identified for the Site RI:

- Drilling spoils from soil generated during the installation of soil borings, water table monitoring wells and piezometers.
- Groundwater IDW from water table monitoring wells and piezometers includes all water generated during well development, purging, and sampling activities.
- Decontamination wastes from waste fluids generated during decontamination of field equipment, sampling equipment, and personal protective equipment.
- Personal protective equipment from disposable items such as gloves, Tyvek suits, etc. used to implement the health and safety program for the RI.

### **5.2 DRILLING SPOILS**

Drilling spoil will be generated during the advancement of borings to obtain soil samples, and borings advanced to install water table monitoring wells and piezometers. The spoil will be handles as a waste product and appropriately disposed. Wells will be installed using hollow stem auger and mud rotary methods. Drilling mud generated will be stabilized with Portland cement or powdered bentonite and classified as drilling spoil.

The procedures for handling drilling spoil will consist of local accumulation at the drilling site, transfer to a 55 gallon drum, characterization, manifesting, and disposal. Each drum will be clearly labeled with the information necessary to identify the source areas of the drilling spoil

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and the dates of accumulation. Filled drums will be stored at the NSPW storage yard, located north of St. Claire Street. This area is secured by a fence and locked gates to prevent access. Historic investigation activities have resulted in generation of similar wastes and characterization of this material by laboratory analysis has already been completed. A waste profile for these materials exists and all drilling spoils will be disposed as a special solid waste at Onyx's Seven Mile Creek Landfill in Eau Claire, Wisconsin.

Drilling spoils generated during this RI that are different (either physically or contaminant source area) from historic drilling wastes will need to be profiled separately. A composite sample will be collected from the drums of drilling spoil and submitted for laboratory analysis. The Landfill manager will determine what analyses are required to complete the waste profile.

### **5.3 WELL DEVELOPMENT AND PURGE WATER**

Water table monitoring wells and piezometers development and purge water will be handled as a waste product and appropriately disposed. The procedures for handling development/purge water will consist of accumulation at the well or piezometer location in a bulk storage container. The bulk storage container should be periodically inspected to assure it does not leak. If a leak is observed, the container will be repaired or replaced.

All development/purge water will be disposed and treated at the on-site coal tar recovery system building. The development/purge water will be pumped directly into the surge tank located between the air diffuser and bag filters. Any water containing NAPLs will be pumped into the gravity separator. The water should be pumped at a rate as to not overload the treatment system. When not in use, the bulk storage container will be stored on-site next to the recovery system building. This area is secured by a fence and locked gates to prevent access.

### **5.4 DECONTAMINATION WASTES**

Wastes associated with the decontamination of field equipment will consist primarily of liquids, with minor amounts of solids. The wastes will be generated by the cleaning of:

1. Soil boring and sampling equipment;
2. Heavy equipment (e.g. drill rig/backhoe);

3. Water table monitoring well and piezometer development equipment; and
4. Personnel exiting the exclusion zone around each sampling location.

Following generation, decontamination water will be placed in a bulk storage container. The decontamination water should be decanted during transfer to the bulk storage container as to minimize the amount of solids transferred. Solids present after decanting will be placed in drums and treated as drilling spoils. The decontamination water will be disposed and treated at the on-site coal tar recovery system building. Procedures for disposal of decanted decontamination water will be the same as disposal of development/purge water.

## **5.5 PERSONAL PROTECTIVE EQUIPMENT**

Waste personal protective equipment (PPE) will be generated during RI activities. Spent waste PPE should be placed in a sealed 55-gallon drum and co-mingled with drilling spoils. Waste PPE that is free of NAPL can be stored in plastic garbage bags and disposed of in a general refuse dumpster.

## **6.0 SCHEDULE**

### **6.1 SCHEDULE**

A schedule for RI/FS tasks is provided in Appendix B.

## 7.0 REFERENCES

### 7.1 REFERENCES

United States Environmental Protection Agency. October 1988, Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. Office of Solid Waste and Emergency Response. EPA/540/G-89/004.

United States Environmental Protection Agency. December 1987, A Compendium of Superfund Field Operation Methods. Office of Emergency and Remedial Response. EPA/540/P-87/001.

United States Environmental Protection Agency. January 1992, Guide to Management of Investigative-Derived Waste (IDW). Office of Solid Waste and Emergency Response. Publication 9345.3-03FS.

United States Environmental Protection Agency. March 2001, Guidance for Preparing Standard Operating Procedures (SOPs). Office of Environmental Information. EPA/240/B-01/004.

United States Environmental Protection Agency - Region IV. November 2001, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual.

## **TABLES**



TABLE

Matrix	Matrix Code	Location	Member Samples	Refills Sampling <sup>1)</sup>	Field Duplicates	Eqpt Blanks	MS/MSO	Refractometers	Field Instrument Used	Parameters	Laboratory Analytical	Sample Preservation	Storage	Storage Time		
Surface Soil	SO	Test Pits (21)	21	1	4	2	2	VOCs	PID	VOCs	EPA 8260	MeOH, 4° C	2 - 60-ml Amber glass	14 Days		
		Kreher Park (3)	3							SVOCs	EPA 8270C	4° C	60-ml Amber glass	14 Days		
		Upper Bluff (8)	8							Cyanide	EPA 336.4	4° C	60-ml plastic jar	14 Days		
		Background (4)	4							Chromium (+6)	EPA 7160A	4° C	60-ml plastic jar	24 Hours		
Subsurface Soil	SO	Near TW-11 (8)	16	1	17	9	9	VOCs	PID	All other metals	EPA 6010B/7471A	4° C	60-ml plastic jar	6 Months		
		Near Deep (12)	24							VOCs	EPA 8260	MeOH, 4° C	2 - 60-ml amber glass	14 Days		
		Upper Bluff (36)	114							SVOCs	EPA 8270C	4° C	60-ml amber glass	14 Days		
		Background (3)	9							Chromium (+6)	EPA 7160A	4° C	60-ml plastic jar	24 Hours		
Forensic PAH <sup>2)</sup>	SO	Test Pits	21	1	9	5	5	VOCs	PID	All other metals	EPA 6010B/7471A	4° C	60-ml plastic jar	6 Months		
		SE	Sediment Tied							PAH	EPA 8270	4° C	4-oz. glass jar	14 Days		
										TOC	EPA 8000	4° C	4-oz. glass jar	14 Days		
										Lab specific	Lab specific	none	4-oz. glass jar	None		
Groundwater	GW	Piezometers Monitoring Wells & Artesian Wells Site Wide	67	4 <sup>3)</sup>	7	-	4	Temperature pH Conductivity Diss. Oxygen	Water Quality Meter	HR Fingerprint	EPA 8016	4° C	4-oz. glass jar	14 Days		
										Adjusted PAH	EPA 8270C	4° C	4-oz. glass jar	14 Days		
										Biomarker Fingerprint	EPA 8270	4° C	4-oz. glass jar	14 Days		
										VOCs	EPA 8260	HCl, 4° C	3 - 40 ml Vials	14 Days		
Porewater	GW	Pressure Diffusion Bags	6	1	1	-	1	-	-	SVOCs	EPA 8270C	4° C	2 - 1 L amber jars	7 Days		
										Cyanide	EPA 336.4	HNO <sub>3</sub> , 4° C	1 - 250 ml plastic jar	14 Days		
										Chromium (+6)	EPA 7160A	4° C	1 - 250 ml plastic jar	24 Hours		
										Total Metals	EPA 6010B/7471A	HNO <sub>3</sub> , 4° C	1 - 250 ml plastic jar	6 Months		
Soil Vapor	GS	Upper Bluff	12	2	2	-	1	-	-	Diss. Metals <sup>4)</sup>	EPA 6010B/7471A	HNO <sub>3</sub> , 4° C	1 - 250 ml plastic jar	6 Months		
										VOCs	EPA 8260	HCl, 4° C	3 - 40 ml Vials	14 Days		
										TO-15A	None	6L Pressurized SUMMA Canister	30 Days			
										VOCs	TO-15A	None	6L Pressurized SUMMA Canister	30 Days		
Indoor Air Vapor	AA	Indoor Air	1	2	1	-	1	-	-	VOCs	TO-15A	None	6L Pressurized SUMMA Canister	30 Days		
		Subslab	1							VOCs	TO-15A	None	6L Pressurized SUMMA Canister	30 Days		
		Background	1							VOCs	TO-15A	None	6L Pressurized SUMMA Canister	30 Days		
		Background	1							VOCs	TO-15A	None	6L Pressurized SUMMA Canister	30 Days		
Surface Water	WS	BERA (6)	16	2	3	-	2	Temperature pH Conductivity Diss. Oxygen	Water Quality Meter	VOCs	EPA 8260	HCl, 4° C	3 - 40 ml Vials	14 Days		
		Reference (2)	4							PAH	EPA 8270	4° C	2 - 1 L amber jars	14 Days		
		H-RFA (6)	6							TOC	EPA 8000	4° C	1 - 250 ml plastic jar	14 Days		
		Reference (2)	2							Chromium (+6)	EPA 7160A	4° C	1 - 250 ml plastic jar	24 Hours		
Preliminary Sediment	SE	Tied Stations (8)	24	1	3	2	2	-	-	Total Metals	EPA 6010B/7471A	HNO <sub>3</sub> , 4° C	1 - 250 ml plastic jar	6 Months		
		SE	Tied Stations (8)							PAH	EPA 8270	4° C	60-ml Amber glass	14 Days		
										SVOCs	EPA 8270C	4° C	60-ml amber glass	14 Days		
										Metals	EPA 6010B/7471A	4° C	60-ml plastic jar	6 Months		
Sediment Tied Sampling	SE	Reference (4)	20	1	7	4	4	-	-	Grain Size	ASTM D422	none	60-ml plastic jar	14 Days		
		SE	Tied Stations (8)							TOC	EPA 8000	4° C	60-ml plastic jar	14 Days		
										Lab specific	Lab specific	4° C	60-ml glass jar	14 Days		
										Lab specific	Lab specific	4° C	60-ml glass jar	14 Days		
Sediment Stability Sampling	SE	Erosion Testing	5	1	1	1	1	-	-	Erosion Testing	EPA D422	4° C	60-ml glass jar	14 Days		
		SE	Age Dating							Lab specific	Lab specific	4° C	60-ml glass jar	14 Days		
										ASTM D422	ASTM D422	4° C	60-ml glass jar	14 Days		
										ASTM D422	ASTM D422	4° C	60-ml glass jar	14 Days		
Supplemental Sediment Sampling	SE	Chequamegon Bay	14	1	2	1	1	-	-	PAH	EPA 8270	4° C	60-ml glass jar	14 Days		
										VOC	EPA 8260	MeOH, 4° C	2 - 60-ml amber glass	14 Days		
										SVOC	EPA 8270C	4° C	60-ml amber glass	14 Days		
										Metals	EPA 6010B/7471A	4° C	60-ml plastic jar	6 Months		
Fish Tissue <sup>5)</sup>	TA	BERA (whole)	16	1	4	2	2	-	-	Grain Size	ASTM D422	none	60-ml plastic jar	6 Months		
										TA	BERA (whole)	TOC	EPA 8000	4° C	60-ml plastic jar	14 Days
												TOC	EPA 8000	4° C	60-ml plastic jar	14 Days
												TOC	EPA 8000	4° C	60-ml plastic jar	14 Days

<sup>1)</sup> The number of samples reflects the number of samples per round of sampling where applicable

<sup>2)</sup> Forensic PAH analyses to be performed by Woods Hole Group Analytical Laboratories

<sup>3)</sup> Includes collection of groundwater samples in June 2004, September 2004, December 2004, and March 2005

<sup>4)</sup> Dissolved metals are Acid Bleached

<sup>5)</sup> Fish tissue samples will include 16 samples each from two target species. Target species include Walleye, Northern Pike, Yellow perch, Smallmouth bass, Lake trout, or Round Whitefish. Of the 16 samples, eight will be submitted as whole fish and the remaining eight will be submitted as fillet samples

**Table 2**  
**Field Sampling Plan**  
**Ashland / NSP Lakefront Superfund Site - Ashland, Wisconsin**  
**Analyte List for Soil, Sediment, and Groundwater Samples**

<b>Analyte</b>	<b>Analyte</b>	<b>Analyte</b>
<b>VOCs</b>	<b>SVOCs</b>	<b>Inorganics</b>
Benzene	Acenaphthene	Arsenic
sec-Butylbenzene	Acenaphthylene	Aluminum
Ethylbenzene	Anthracene	Antimony
Styrene	Benzo(a)Anthracene	Barium
Toluene	Benzo(a)Pyrene	Beryllium
1,2,3-Trimethylbenzene	Benzo (e) Pyrene	Cadmium
1,2,4-Trimethylbenzene	Benzo(b)Fluoranthene	Calcium
1,3,5-Trimethylbenzene	Benzo (k) Fluoranthene	Chromium (+3)
Total Xylenes	Benzo(g,h,i)Perylene	Chromium (+6)
	Chrysene	Cobalt
	Dibenzo(a,h)Anthracene	Copper
	Fluoranthene	Cyanide
	Fluorene	Iron
	Indeno(1,2, 3-cd)Pyrene	Lead
	1-Methyl Naphthalene	Magnesium
	2-Methyl Naphthalene	Manganese
	Naphthalene	Mercury
	Phenanthrene	Nickel
	Pyrene	Potassium
	Dibenzofuran	Selenium
	Phenol	Silver
	2-Methyl Phenol	Sodium
	3-Methyl Phenol	Thallium
	4-Methyl Phenol	Vanadium
		Zinc

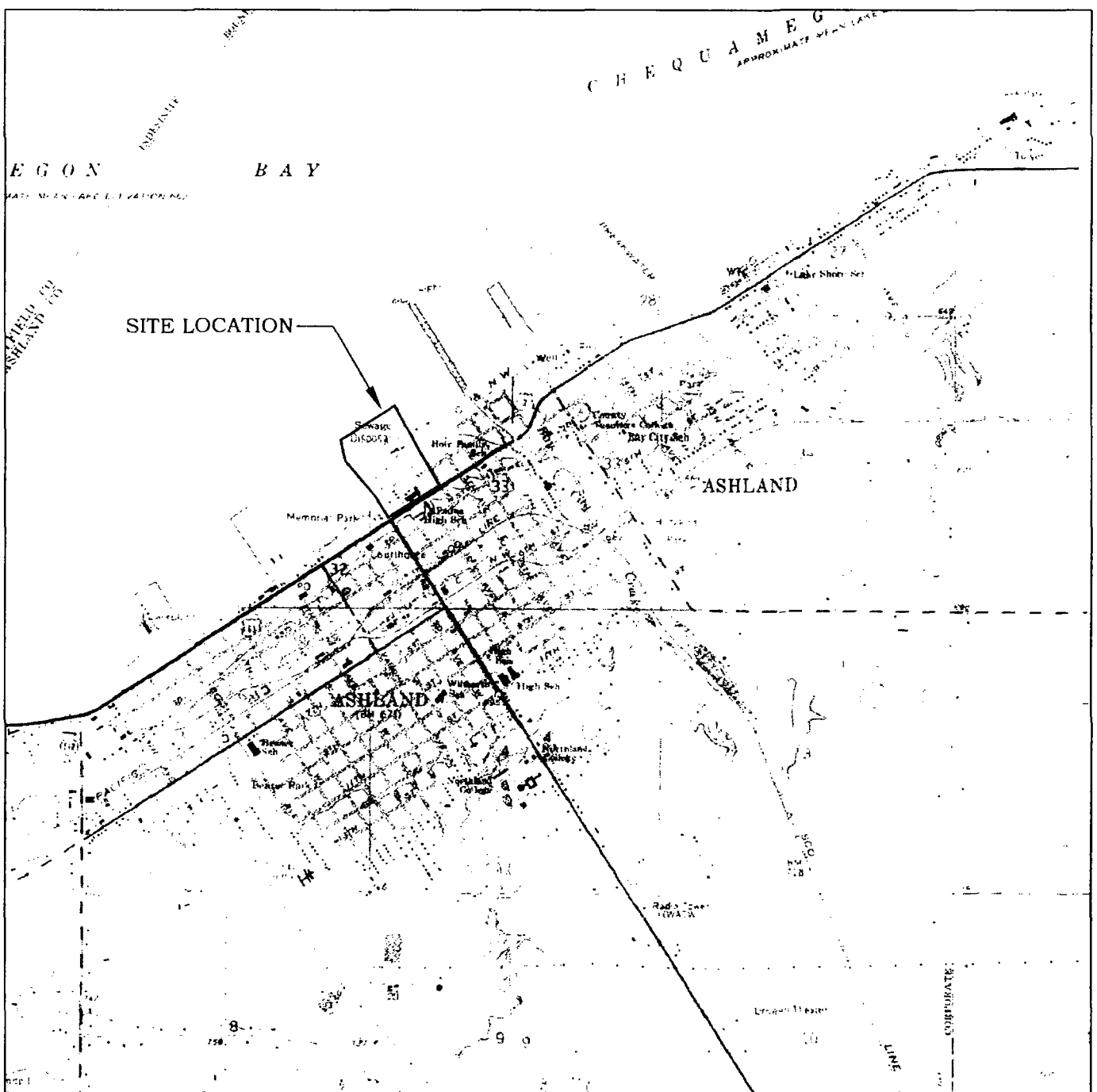
**Table 3**  
**Field Sampling Plan**  
**Ashland / NSP Lakefront Superfund Site - Ashland, Wisconsin**  
**Analyte List for TO-15 Air Samples**

VOCs
1,1,1-Trichloroethane
1,1,2,2-Tetrachloroethane
1,1,2-Trichloroethane
1,1-Dichloroethane
1,1-Dichloroethene
1,2,4-Trichlorobenzene
1,2,4-Trimethylbenzene
1,2-Dibromoethane (EDB)
1,2-Dichlorobenzene
1,2-Dichloroethane
1,2-Dichloropropane
1,3,5-Trimethylbenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
Benzene
Benzyl chloride
Bromomethane
Carbon tetrachloride
Chlorobenzene
Chloroethane
Chloroform
Chloromethane
cis-1,2-Dichloroethene
cis-1,3-Dichloropropene
Dichlorodifluoromethane
Ethylbenzene
Hexachlorobutadiene
m-Xylene
o-Xylene
p-Xylene
Methylene chloride
Styrene
Tetrachloroethene
Toluene
trans-1,3-Dichloropropene
Trichloroethene
Trichlorofluoromethane
Vinyl chloride

**Table 4**  
**Field Sampling Plan**  
**Ashland / NSP Lakefront Superfund Site - Ashland, Wisconsin**  
**QA Objectives For Groundwater Field Measurements**

<b>Parameter</b>	<b>Method Reference</b>	<b>Precision</b>	<b>Accuracy</b>	<b>Completeness</b>
Standing Water Levels	Solinst	$\pm 0.01$ ft.	0.005 ft.	95%
Monitoring Well Water Temperature	E170.1, Electronic Temperature Probe	$\pm 0.5$ degrees C	1.0 degrees C	95%
Conductivity	E120.1, Electrometric	$\pm 25$ uhmo/cm <sup>2</sup>	10 uhmo/cm <sup>2</sup>	95%
pH	E150.1, Electrometric	$\pm 0.1$ pH units	0.05 pH units	95%
Turbidity	E180.1	10 NTU	0.5 NTU	95%
Dissolved Oxygen	ASTM - A4500	$\pm 0.05$ mg/L	$\pm 0.1$ mg/L	95%

## FIGURES



BASE MAP SOURCE: USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE, ASHLAND, WISCONSIN, DATED 1964, PHOTOREVISED 1975.



QUADRANGLE LOCATION



NORTH

0 1320 2640 5280

SCALE IN FEET

PROJECT:

ASHLAND/NSP LAKEFRONT SITE  
ASHLAND, WISCONSIN

TITLE:

FIGURE 1  
SITE LOCATION MAP

DRAWN BY: BRN

SCALE: 1" = 2640'

PROJ. NO. 25688375

CHECKED BY: DPT

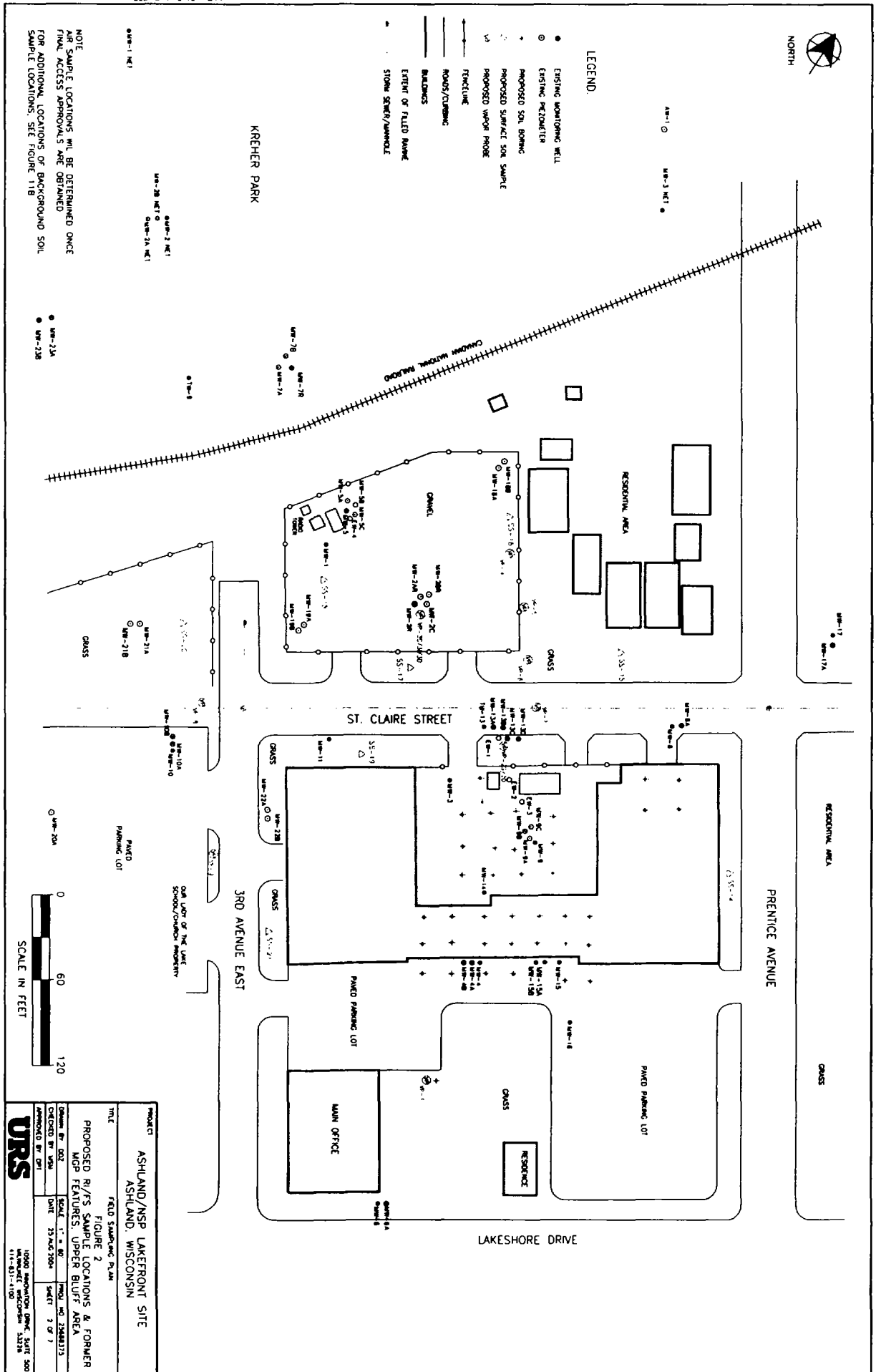
DATE: 13.FEB.2004

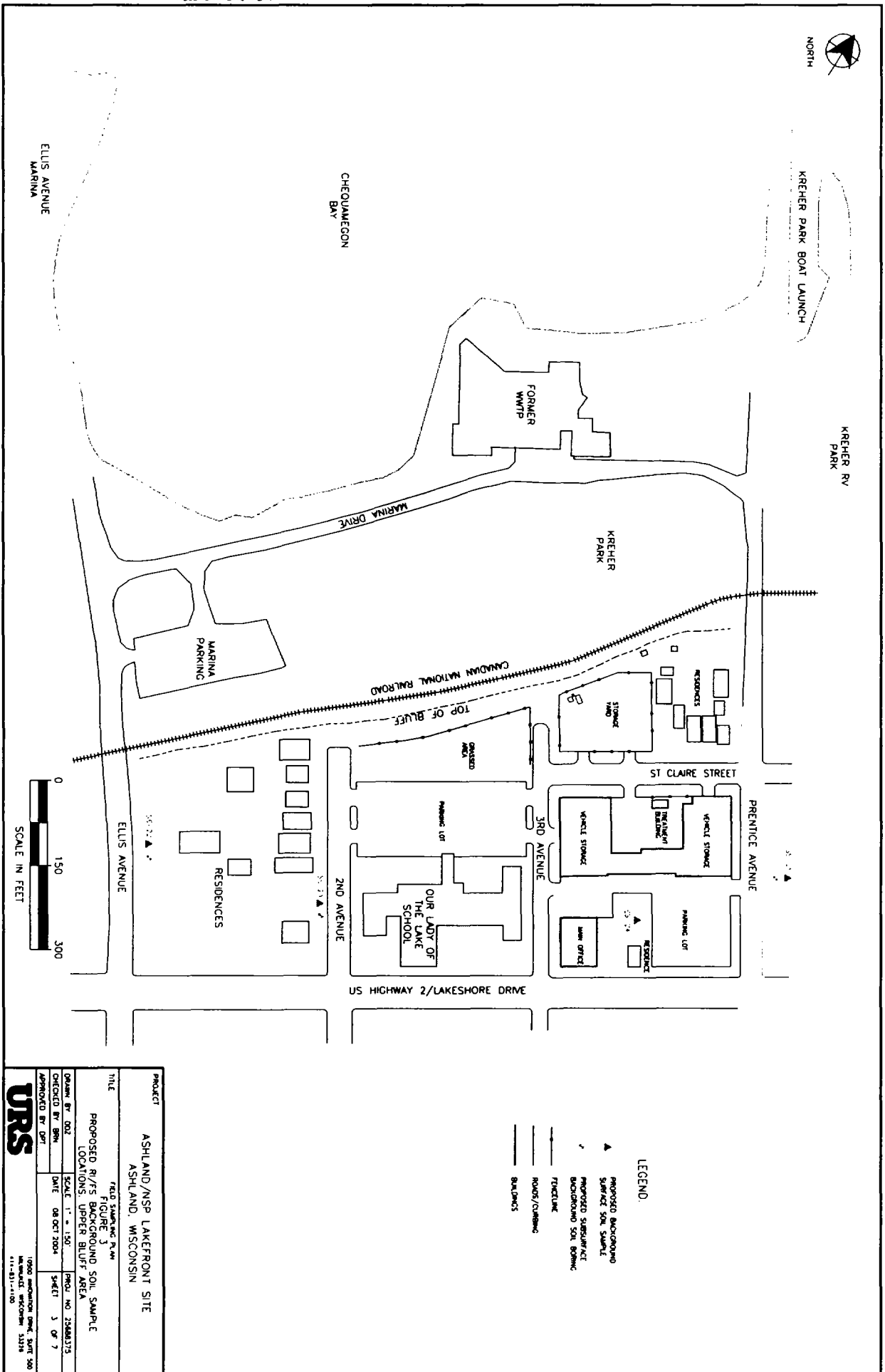
SHEET: 1 OF 7

APPROVED BY: DPT

**URS**

10200 INNOVATION DRIVE, SUITE 500  
MILWAUKEE, WISCONSIN 53226  
414-831-4100

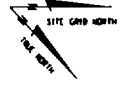








# FIELD SAMPLING PLAN



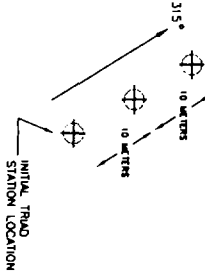
REISS  
CDAL  
DOCK

CHEQUAMECON  
BAY

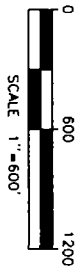
CANADIAN  
DOCK

CLARKSON  
DOCK

DETAIL OF TRIAD STATION LOCATION -  
RECONNAISSANCE SAMPLING



NOTES:  
BASE MAP FROM SEN DRAFT FEASIBILITY  
STUDY, DATED FEBRUARY 1996.



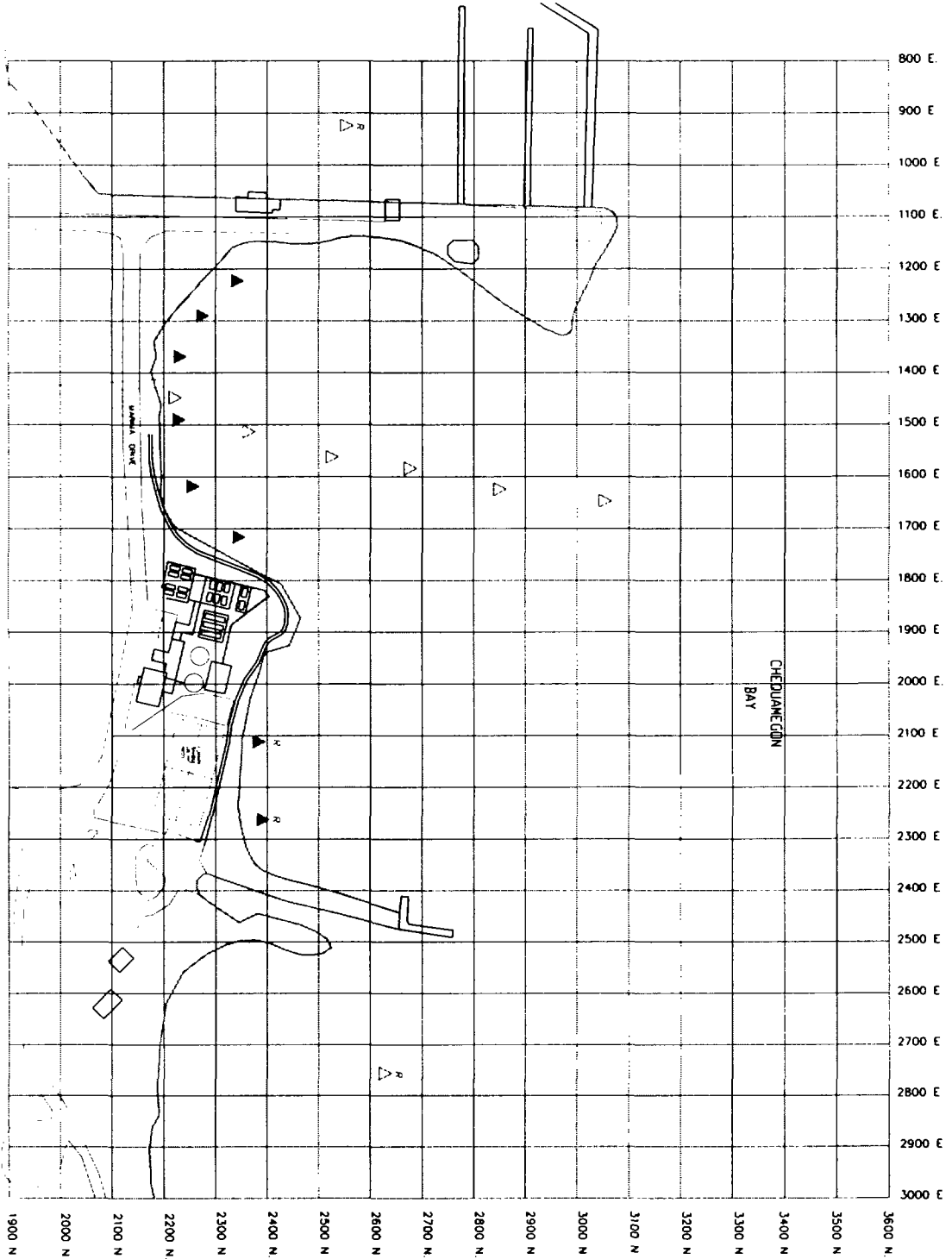
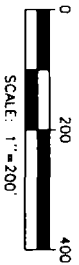
## LEGEND

- HISTORIC SEDIMENT  
SAMPLE LOCATIONS
- CANDIDATE TRIAD SAMPLE LOCATION  
(CR DENOTES REFERENCE STATION)
- SUPPLEMENTAL SEDIMENT SAMPLE  
LOCATIONS

PROJECT		ASHLAND/NSP LAKEFRONT SITE	
TITLE		FIELD SAMPLING PLAN	
FIGURE		FIGURE 5	
PROPOSED BLT'S TRIAD AND SUPPLEMENTAL SAMPLE LOCATIONS FOR BAY SEDIMENTS			
DESIGNED BY	DATE	SCALE	PROJECT
DESIGNED BY: VLS	DATE: 11 OCT 2000	SCALE: 1"=600'	PROJECT: 5 OF 7
APPROVED BY: JPI	DATE: 11 OCT 2000		

# FIELD SAMPLING PLAN

NOTES:  
BASE MAP FROM SEH DRAFT FEASIBILITY  
STUDY, DATED FEBRUARY 1996



## LEGEND

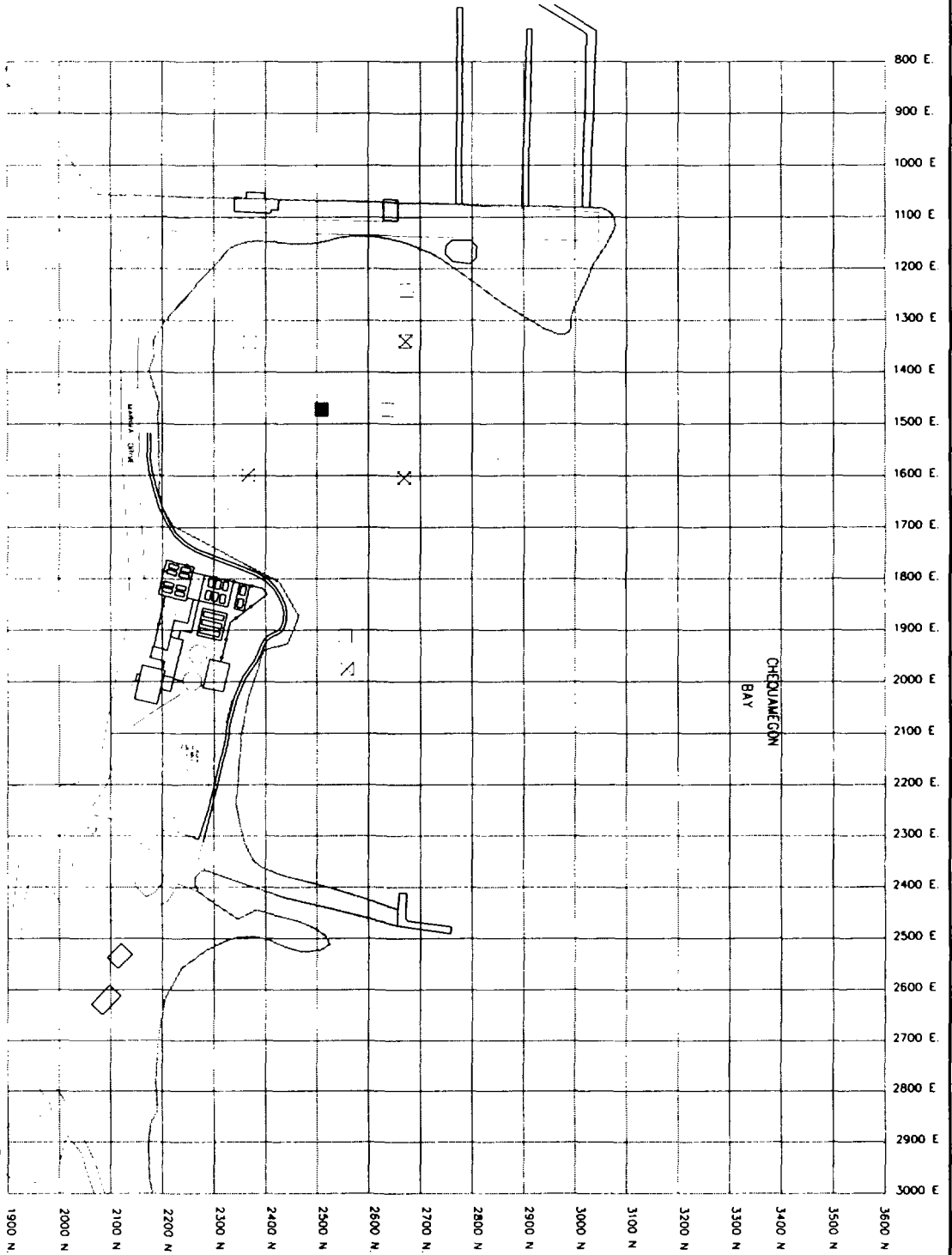
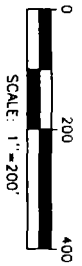
- △ SURFACE WATER SAMPLE FOR ECOLOGICAL RISK ASSESSMENT ("R") DEMONSTRATION STATION
- ▲ SURFACE WATER SAMPLE FOR HUMAN DEMONSTRATION STATION

PROJECT		ASHLAND/NSP LAKEFRONT SITE	
TITLE		FIELD SAMPLING PLAN	
DRAWN BY: 002		SCALE: 1"=200'	
CHECKED BY: VAS		DATE: 08 OCT 2004	
APPROVED BY: DT		SHEET: 6 OF 7	
PROJECT NO: F948873		DATE: 08 OCT 2004	
PROJECT NO: F948873		DATE: 08 OCT 2004	
PROJECT NO: F948873		DATE: 08 OCT 2004	

URS

# FIELD SAMPLING PLAN

NOTES  
BASE MAP FROM SEH DRAFT FEASIBILITY  
STUDY, DATED FEBRUARY 1996



## LEGEND

- SEDMENT STABILITY SAMPLE  
(AGE-DATING CORES)
- SEDMENT STABILITY SAMPLE  
(EROSION TEST CORES)
- SEDMENT STABILITY SAMPLE  
(ACOUSTIC DOPPLER TRIPOD)

PROJECT			
ASHLAND/NSP LAKEFRONT SITE			
ASHLAND, WISCONSIN			
FIELD SAMPLING PLAN			
FIGURE 7			
PROPOSED R/F/S SEDIMENT STABILITY			
SAMPLE LOCATIONS FOR BAY SEDIMENTS			
DATE: 02/02/96	SCALE: 1"=200'	FIG. NO. 7000-0175	
CHECKED BY: GWT	DATE: 06/07/96	SHEET: 1 OF 7	
APPROVED BY: GWT			
URS			
UNIVERSITY OF WISCONSIN RESEARCH SYSTEMS			
1000 UNIVERSITY AVENUE, SUITE 1000			
MADISON, WISCONSIN 53706			

**RES**

**RNA**

**FIE ~~S~~ ~~H~~ ~~O~~ ~~R~~ ~~N~~ RØDRES**

**Standard Operating Procedure**

**For**

**Water Level Measurement**

Prepared by: \_\_\_\_\_

Date: \_\_\_\_\_

Reviewed by: \_\_\_\_\_

Date: \_\_\_\_\_

Approved by: \_\_\_\_\_

Date: \_\_\_\_\_

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<b>3.0 EQUIPMENT NEEDED.....</b>	<b>3</b>
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## **1.0 SCOPE**

This operating procedure describes methods for measuring and recording manual water level measurements in wells by means of an electronic or mechanical device. Water levels may be observed with steel or fiberglass tapes by a "popper" weight, which makes a popping sound when it strikes the water surface. An electrical tape may also be used which transmits and activates a sound (BEEP) in response to its electrode contact with the water surface.

## **2.0 OBJECTIVES**

This standard procedure is intended to:

- Assure that water levels measured at different times and by different personnel are comparable, uniform, and reliable.
- Allow traceability of errors in water level measurement, and correction of improper procedures.
- Assure the data obtained in the field are complete and of satisfactory precision and accuracy.

## **3.0 EQUIPMENT NEEDED**

- Steel, fiberglass or electrical tape. Steel or fiberglass tapes should be graduated in feet to hundredths. Electrical tapes may be graduated only at 5-foot intervals.
- Pocket steel tape or folding ruler (graduated in feet to hundredths).
- Permanent marker for marking well with its number and marking the measure point.
- Pre-printed water-level measurement forms.
- Field notebook.
- Batteries for electrical tape.
- Clean rags or Kimwipes.
- Distilled or de-ionized water; organic-free if well is to be sampled for organics.

## **4.0 CALIBRATION**

Prior to initial use, the water level tape should be checked against a standard steel tape with calibration traceable to the National Bureau of Standards. The calibration tape should not be used for field measurements, but only for calibrating field tapes. New field tapes will be calibrated against the standard tape before use by stretching both along a flat level surface and applying to each a tension approximately equal to the weight of the tape. For each 10 feet of distance along the standard tape, record the corresponding reading of the field tape on a Tape Calibration Record.

## **5.0 MEASURING POINT**

The measuring point is the fixed point on the well from which all water level measurements are taken. The selected point is generally the highest point on top of the PVC casing where the well elevation has been determined.

The measuring point must be permanently marked. Usually it will be most convenient to put a spot of permanent ink on the PVC casing rim, with an arrow and the letters "MP" pointing to it.

Experience shows that considerably more error in ground water level measurements comes from mistaking the identity of a well or the location of the proper measuring point than from errors in the actual measurement. It is essential that the well and measuring point be clearly identified. If field inspector or technician notices an unmarked well, they should make sure that the well number and measuring point location are permanently marked. The well number may be painted on the outside of the casing or inside of the protective cap, as long as it is obvious to anyone opening the well for measurement.

## **6.0 PRELIMINARY TO OPERATION**

1. Inspect tape to make sure that is complete and moves freely in its case. Make sure that popper is firmly attached and that its lower end is a convenient distance (for example, 0.50 feet) below the zero mark on the tape. Record the distance on the field log.
2. Inspect electrode tip of electric tape. Test batteries, and test operation of tape in the laboratory by placing electrode in tap water and making sure that the meter or other indicator responds. Make sure that the effective position of the electrode corresponds to the zero position on the tape. If the electrode has been repaired or replaced, the zero position may have been affected. Note any discrepancy in the field notes and notify the laboratory manager.

## **7.0 CLEANING**

Instruments used for water level measurements will be decontaminated between each monitoring well in accordance with SOP 190.

## **8.0 MEASUREMENT METHODS**

Two measurement methods are described.

- Measurement with popper. A popper should only be used in wells with suspected NAPL that may interfere with operation of an electric tape. SOP 270 discusses measuring NAPL present in monitoring wells.
- Measurement with electric tape. Use of appropriate method should be determined based on the existing conditions and upon discussions with the project hydrogeologist and Quality Assurance Officer.

All water level measurements in a particular sampling round should be made using the same electric meter.

### 8.1 Measurement with Popper

1. This method is simple, fast, and fairly accurate. Precision is approximately  $\pm 0.02$  feet, but may be less under unfavorable conditions. Accuracy depends on the tape used. Occasionally, conditions in the well or outside noise will make it impossible to hear the popper, and measurements with electric tape should be employed.
2. Lower the tape into the well until the hollow-bottomed weight strike the water surface and causes a popping sound. Hold the tape near the measuring point, and raise and lower several times to determine the water surface as closely as possible.
3. Record the actual number of feet that appears opposite the measuring point, i.e., do not add the "popper correction"--the distance from the tape zero mark to the bottom of the popper--before recording the number. Read the tape to the nearest  $\pm 0.01$  feet. Record the popper correction on the field log and add to the measured water depth.

### 8.2 Measurement with Electrical Tape

1. This method is preferred over using popper methods. Its precision may be limited by uncertainties in interpreting the sensing meter. Accuracy may be as low in measuring deep wells because of tape stretching. This method should be used with caution if high accuracy is important, for example in pumping tests. It may be preferred, however, in deep wells or in water table wells where other methods are not feasible, or in noisy situations.
2. Turn on the electrical water sensor. Lower the tape into the well until it produces a beep or other response. Raise and lower the tape a few times to confirm that the water level has been detected.
3. Once the water level is detected, note the value on the measuring tape at the mark noted on the top of the well casing. If the well casing does not have a mark, note the value on the measuring tape along the northern edge of the well casing.
4. Record the measured value in the field logbook or well sampling form.
5. Decontaminate the electrical tape in accordance with SOP 190.

## 9.0 RECORD KEEPING

Whenever possible, use pre-printed forms, since these will minimize the risk of missing some important information. If taking notes in a field log, however, the following should be recorded:

- Well number and location. All too often a single well is assigned two or more different numbers; if at all possible, record them all to avoid confusion for future users of the records.
- Date and time of measurement.
- Field observer's name.

- 
- Serial number of tape used.
  - Measuring point description, including whenever possible its sea level elevation, stickup (the distance from the ground surface to the measuring point). Be sure to note whether the measuring point is above or below ground surface.
  - Method of measurement.
  - Tape readings.
  - Factors that may influence the water level -- for example, recent pumping of the well or nearby wells.
  - Damage or alterations to the well or settlement that may have occurred since the last measurement.

As soon as possible, the measurements should be reduced in the office to elevation above sea level for long-term data storage. This is important because alteration or damage to wells changes the measuring point elevation, so that measurements of depth to water before and after this change are not comparable. The resulting confusion is difficult to sort out.

## **10.0 WELL SURVEY**

During a well survey, the surveyor should obtain elevations of both the measuring point and the ground surface. If a concrete pad surrounds a well, surveyor should also permanently mark a spot on the pad and determine its elevation. This allows easy determination of a new measuring point elevation if the well is damaged or modified.

**Standard Operating Procedure**  
**For**  
**Groundwater Field Parameter Measurement**

Prepared by: \_\_\_\_\_

Date: \_\_\_\_\_

Reviewed by: \_\_\_\_\_

Date: \_\_\_\_\_

Approved by: \_\_\_\_\_

Date: \_\_\_\_\_

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<b>4.0 PRELIMINARY TO OPERATION .....</b>	<b>3</b>
<b>5.0 OPERATING PROCEDURE.....</b>	<b>5</b>

**Attachments****Form 110-A Instrument Calibration Log**

## **1.0 SCOPE**

This operating procedure describes the operation, calibration, and maintenance of a water quality meter and its accessories for use in the field. Manufacturer's specifications and recommendations should be followed or referred to as and when need arises.

## **2.0 OBJECTIVES**

The activities covered by this procedure:

- Insure quality control in field pH measurement.
- Insure uniformity and continuity in operation, calibration, and maintenance of both the equipment and measuring techniques by different qualified field analysts or technicians.

## **3.0 EQUIPMENT NEEDED**

- Water quality meter and its accompanying electrode or probe\*;
- Buffer solutions of known pH (4.0, 7.0, and 10.0);
- Calibration standard for conductivity (1409  $\mu$ S);
- Plastic or glass beakers or cups;
- Flow-through cell and tubing (if specified in work plan);
- Distilled or de-ionized water;
- Polyethylene spray bottle;
- Waterproof marking pen or pencil;
- Liquid waste container;
- Lint free paper towels;
- Trash receptacle; and
- User's manual for water quality meter.

\* The water quality meter should be a YSI 556 MPS or equivalent.

## **4.0 PRELIMINARY TO OPERATION**

At the start of each field day, the water quality meter should be examined for cleanliness, and checked for defects, and any possible need of repair. The checks should include whether the battery and electrode are operable. The meter should also be calibrated at the start of each day, with intermittent calibration checks throughout the day to determine whether recalibration is necessary. The following procedures should be performed at the start of each field day:

**Battery check** to determine if battery is functional to full scale. Batteries are replaced if found weak.

- **Electrode check** in accordance with the user's manual from the manufacturer. If the electrode check indicates potential problems with the electrode, a different electrode and/or water quality meter must be obtained or the electrode must be repaired before going into the field.
- **Meter calibration** in accordance with the user's manual from the manufacturer. Calibration schedule should include daily calibration, and intermittently, when required, during continuous use of the meter.

Calibrate the water quality meter in accordance with the user's manual provided by the manufacturer. Calibration for specific conductivity meter should be made with a standard of approximately the same conductivity as those expected at the site, and should be measured at (or converted to) 25°C. Some conductivity meters automatically compensate for temperature, some compensate after the user adjusts a temperature knob on the meter to the measured temperature, and others have no temperature compensation feature. Refer to the user's manual to determine what temperature compensation features the conductivity meter has and follow the directions. The calibration of the field instruments must be checked every four hours and at the end of the day. If the calibration check is not within  $\pm 5\%$  of the expected value, the meter must be recalibrated. Record calibration information in the field logbook or on an instrument calibration data sheet.

Instrument calibration for pH consists of calibration of the water quality meter with pH 7 and pH 10 buffers, and a pH 4 buffer as a check, or with pH 7 and pH 4 buffers, and a pH 10 buffer as a check, depending on the average expected pH values of the samples.

The calibration for pH is temperature correlated. Please note the **actual** pH of your buffers at the temperature used for calibration. (A chart for this is usually provided on the buffer container.) If the pH meter does not have automatic temperature compensation, you may need to calibrate the 7 buffer to 6.95 or 7.03, or some point in between, depending on the temperature of your buffers. Some water quality meters compensate for temperature, but require the user to set a temperature knob on the meter to the measured value. Refer to the user's manual to determine what temperature compensation features the meter has, if any, and follow the meter-specific instructions.

Calibration should be accomplished through the following steps:

1. Place the electrode in the pH 7 buffer solution and adjust the meter to read 7.0, or the appropriate value given on the buffer container.
2. Rinse the electrode with de-ionized water.
3. Place the electrode in the pH 4 or pH 10 buffer and adjust the meter slope until the meter reads the appropriate value.
4. Rinse the electrode with de-ionized water.
5. Place the electrode in the pH 4 or pH 10 buffer, whichever was not used in Step 3, and read the pH of the check buffer. If the value is not within 0.1 pH unit of the expected value, repeat the calibration procedure. If the meter cannot be successfully calibrated on several successive attempts, another meter should be used or the meter should be repaired prior to use.
6. Record calibration information in the field logbook or on a calibration data sheet. Note any problems encountered during calibration.



- 
- **Scheduled maintenance** will include daily checks by URS trained personnel according to procedures provided by the equipment's manufacturer.
  - **Repairs** and scheduled service will be performed by an authorized service representative. Scheduled service will be completed in accordance with the manufacturers specifications.

## **5.0 OPERATING PROCEDURE**

1. Turn on power and allow meter to stabilize for about three to five minutes. *Caution: Do not leave or use meter in direct sunlight or cold wind.*
2. Place water sample in beaker or cup. If using a flow-through cell with a pump, connect pump tubing to cell and attach discharge tubing to cell. Discharged water should be handled in accordance with the Investigative Derived Waste management plan.
3. Insert electrode into sample and gently stir. If using a flow through cell, connect electrode to cell and turn on pump. Allow a minimum of 30 seconds for readings to stabilize.
3. Once readings have stabilized, record the pH reading, specific conductivity, dissolved oxygen content, and sample temperature in the field logbook or on a data sheet.
4. Obtain one duplicate field measurement for every 20 measurements performed. Initial measurement and duplicate measurement should be within 20 percent.
5. Once groundwater field parameter measurements are completed, remove electrode from sample and rinse with deionized water. Dispose of sample in accordance with the Investigative Derived Waste management plan.



## FORM 110-A

## INSTRUMENT CALIBRATION LOG

INSTRUMENT:		
MANUFACTURER:		
MODEL NUMBER:		
SERIAL NUMBER:		
URS ASSET NUMBER:		
DATE ACQUIRED OR SERVICED:		
ORIGINAL OR PREVIOUS CALIBRATION DATE:		
CALIBRATED BY:		
NOTES ON ORIGINAL OR PREVIOUS CALIBRATION:		
CALIBRATION SCHEDULE: (circle one)      DAILY      MONTHLY      YEARLY		
MAINTENANCE SCHEDULE: (circle one)      DAILY      MONTHLY      YEARLY		
<b>CURRENT CALIBRATION RECORD:</b>		
DATE:	TIME:	
CALIBRATION STANDARD(S) USED:		
CONCENTRATION(S):		
PROCEDURE (describe briefly):		
DEFICIENCIES: (if any):		
CALIBRATION PLOTS OR GRAPHS (attach, if any)		
SIGNATURES:		
Name: _____		Date: _____

**Standard Operating Procedure**  
**For**  
**Well Drilling, Construction, and Development**

Prepared by: \_\_\_\_\_

Date: \_\_\_\_\_

Reviewed by: \_\_\_\_\_

Date: \_\_\_\_\_

Approved by: \_\_\_\_\_

Date: \_\_\_\_\_

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**Attachments**

<b>FORM 4400-122</b>	<b>WDNR Soil Boring Log</b>
<b>FORM 4400-113A</b>	<b>WDNR Monitoring Well Construction</b>
<b>FORM 4400-113B</b>	<b>WDNR Monitoring Well Development</b>
<b>FORM 3300-5</b>	<b>WDNR Borehole Abandonment</b>

## **1.0 SCOPE**

This operating procedure describes steps involved in typical well drilling, well construction, and well development for monitoring wells and piezometers in accordance with Wisconsin Chapter NR 141 requirements. Decontamination procedures should be followed to prevent the possibility of cross contamination between drilling locations.

## **2.0 OBJECTIVES**

The activities covered by this procedure:

- Insure that monitoring wells and piezometers are installed properly in accordance with NR 141.
- Insure that minimal chance of cross contamination will occur between well locations.
- Observe safe working conditions for all personnel.

## **3.0 EQUIPMENT NEEDED**

- Drill rig capable of installing wells to the desired depth in the expected formation materials and conditions
- Well casing and well screen
- Bentonite pellets
- Filter pack sand
- Portland Type I or II Cement and powdered bentonite for grouting
- Protective well casing with locking cap
- High-pressure steamer/cleaner
- Long-handled bristle brushes
- Wash/rinse tubs
- Appropriate decontamination supplies as specified in SOP 190 Decontamination Procedures
- Location map
- Plastic bags (Ziploc)
- Self-adhesive labels
- Weighted tape measure
- Water level probe
- Deionized water
- Appropriate health and safety equipment as specified in the Health and Safety Plan (HSP)
- Log book

- Boring log sheets
- Well construction form
- Plastic sheeting
- Drums for containment of cuttings and Decontamination and/or development water (if necessary)

#### **4.0 PRELIMINARY TO OPERATION**

1. Contact Digger's Hotline to clear all utilities near drilling areas at least three days prior to start of work.
2. Review project Workplan for site-specific drilling locations and procedures.
3. Review project Health and Safety Plan with all personnel prior to start of work.
4. Secure exclusion zone around all drilling equipment to eliminate entry by unauthorized personnel.

#### **5.0 DRILLING PROCEDURES**

Boreholes will be advanced using conventional drilling methods and a drill rig capable of completing the monitor well(s) and piezometers to the depth(s) specified in the Workplan. Before drilling, well locations will be numbered and staked according to locations specified in the Workplan.

During the drilling operations, the soil cuttings from the boring will be placed into 55-gallon drums and labeled. Disposal of cuttings will be in accordance with the Workplan and the Investigative Derived Waste Management Plan, described in Section 5.0 of the Field Sampling Plan. All soil boring information will be recorded on Form 4400-122.

##### **Monitor Well Drilling Operations**

The procedures for drilling are as follows:

- Set up drilling rig at staked and cleared borehole location.
- Record location, date, time and other pertinent information in the field book.
- Drill hole of appropriate size using hollow-stem augers.
- Collect split-spoon samples at the predetermined intervals, if appropriate, for sample description as specified in the Workplan. See SOP 140, Soil Sample Collection, for specific instruction.
- Complete the borehole to the depth specified in the Workplan.

##### **Well Design Specifications**

The following general specifications will be:

**Boring Diameter:** The boring will be of sufficient diameter to permit at least two inches of annular space between the boring wall and all sides of the centered riser and screen. The boring diameter will be of sufficient size to allow for the accurate placement of the screen, riser, filter pack, seal, and grout. The boring diameter will be 8.5-inches unless otherwise specified in the Workplan.

**Well Casing:** Well riser materials will consist of new threaded, flush joint, PVC casing. Well diameters will be 2-inch unless otherwise specified in the Workplan. Risers will extend approximately two feet above the ground surface, except in the case of flush-mount well casings. The tops of all well casings will be fitted with locking caps.

**Well Screens:** Screen length for each well will be specified in the Workplan. Well screens will consist of new threaded pipe with factory-machine slots with an inside diameter equal to that of the well casing. The slot size will be 0.010-inch and designed to be compatible with aquifer and sand pack material. For water table monitoring wells and piezometers the screen lengths will be 10 feet and 5 feet, respectively, unless otherwise specified in the Workplan. The schedule thickness of PVC screen will be the same as that of the well casing. All screen bottoms will be fitted with a cap or plug of the same composition as the screen and should be within 0.5 foot from the open part of the screen.

## **6.0 WELL CONSTRUCTION**

The following procedures will be initiated within 12 consecutive hours of boring completion for uncased holes or partially cased holes and within 48 consecutive hours for fully cased holes. Once installation has begun, no breaks in the installation procedure will be made if no unusual conditions are encountered until the well has been grouted and the drill casing has been removed. All well construction details will be recorded on Form 4400-113A.

The procedure for monitoring well installation is as follows:

1. Decontaminate all drilling equipment according to SOP 220: Decontamination of Heavy Equipment. Following decontamination, all personnel that handle the casing will don a clean pair of rubber or surgical gloves.
2. Assemble screen and casing as it is lowered into the boring inside the hollow stem augers (HSA).
3. Lower screen and casing to about 6 inches above the bottom of the boring.
4. Record the level of top of casing and calculate the screened interval. Adjust screen interval by raising assembly to desired interval if necessary and add sand to raise the bottom of the boring.
5. Begin adding filter pack sand around the annulus of the casing a few feet at a time. Repeated depth soundings shall be taken to monitor the level of the sand.
6. Allow sufficient time for the filter sand to settle through the water column outside the casing before measuring the sand level.

7. Extend the filter pack sand to at least 2 feet above the top of the well screen.
8. Following sand filter pack placement in the shallow wells, install a minimum 2 foot-thick seal of bentonite chips or pellets by slowly adding them through the HSA to avoid bridging. The thickness of the completed bentonite seal shall be measured before the pellets are allowed to swell. The completed bentonite seal shall be allowed to hydrate before proceeding with the grouting operations.
9. Grout the remaining annulus from the top of the bentonite seal to about 3 feet below the surface as measured after the augers are removed. The grout will be tremied into the borehole using a small diameter pipe until the annulus is completely filled.
10. After the grout sets for 24 hours it will be checked for settlement. If necessary, additional grout will be added to top off the annulus.
11. The concrete pad will be installed according to specifications in this SOP. The protective casing and posts will be installed to provide maximum protection from damage.

**Well Installation Specifications:**

**Filter Pack:** The annular space around the well screen will be backfilled with clean, washed, silica sand sized to perform as a filter between the formation material and the well screen. The filter pack will extend a minimum two feet above the screen. The final depth to the top of the filter pack will be measured directly using a weighted tape measure. The grain size of the filter pack will be shown on the well construction log.

**Bentonite Seal and Grout:** A two-foot thick bentonite pellet/slurry seal will be placed in the annulus above the filter pack. The thickness of the seal may vary slightly based on site conditions. The thickness of the seal will be measured immediately after placement, without allowance for swelling. Bentonite slurry seals should have a thick batter-like consistency. Bentonite slurry grout will be prepared in an above-ground rigid container by thoroughly mixing correct amounts of powdered bentonite and water. The grout will be placed by pumping through a tremie pipe. The lower end of the tremie pipe will be kept within five feet of the top of the bentonite seal. Grout will be pumped through the tremie pipe until undiluted grout flows from the annular space at the ground surface. The tremie pipe will then be removed and more grout added to compensate for settling. After 24 hours, the drilling contractor will check the site for grout settlement and add more grout to fill any depression. This will be repeated until firm grout remains at the surface. Where grout is not required, bentonite chips may be poured directly into the borehole.

**Protection of Well:** Field personnel will at all times during the progress of the work, take precautions to prevent tampering with the wells or entrance of foreign material into them. Upon completion of a well, a cap will be installed to prevent foreign material from entering the well. The wells will be enclosed in a steel protective casing. Steel casings will be, at a minimum, four inches in diameter and will be provided with locking caps and locks. All locks will be keyed alike. The



well designation will be painted on the outside of the protective casing. If specified in the Workplan, a minimum three-foot by three-foot, six to eight-inch-thick concrete pad, sloped away from the well, will be constructed around the protective casing at the final ground level elevation. For a stick up well, bumper posts set in concrete will be spaced equally around the well casing for protection, and will extend approximately one (1) foot above the well riser. Any well that is to be temporarily removed from service or left incomplete due to delay in construction, will be capped with a water tight cap and equipped with a "vandal-proof" cover satisfying applicable state or local regulations or recommendations.

## **7.0 WELL DEVELOPMENT**

All newly installed wells will be developed in accordance with NR 141.21. Piezometers sealed with grout will be developed a minimum of 12 hours after well construction is completed. All monitoring wells and piezometers will be developed by surging and purging with dedicated bailers or surge blocks for a minimum of 30 minutes to remove sediment from the well screen and filter pack. Following surging, 10 well volumes of water will be removed from each well using a dedicated bailer or submersible pump. In the event that a well bails dry, 5 well volumes will be removed or purged until the well produces sediment-free water. All well development information will be recorded on Form 4400-113B.

## **8.0 WELL ABANDONMENT**

Any boreholes or wells that are abandoned must be done so in accordance with NR 141.25. These abandonment requirements must be met for all boreholes that are greater than 10 feet or intersect the water table and all monitoring wells and piezometers. Boreholes will be abandoned by the complete filling of the borehole with bentonite granules, chips, or bentonite slurry. A tremie pipe will be used to deliver sealing materials in boreholes and wells that are greater than 30 feet in depth or with standing water. The following procedures will be followed for the abandonment of monitoring wells and piezometers:

1. The depth to water and the depth to the bottom of the well from the top of casing will be measured and recorded prior to abandonment.
2. The sealing material (bentonite chips or bentonite slurry) will be poured or tremie piped slowly into the well casing to the surface.
3. The well casing will be cut off at least 30 inches below ground surface.
4. The flush mount protective cover or stick up protective pipe will be removed.
5. A concrete surface seal will be placed in all boreholes and wells located in roadways, sidewalks, driveways, and other areas where heavy traffic might damage the surface seal.
6. Native soil will be used a surface seal in grassed and wooded areas.

All monitoring well and borehole abandonment information will be recorded on Form 3300-5.

Page \_\_\_\_\_ of \_\_\_\_\_

Facility/Project Name			License/Permit/Monitoring Number		Boring Number	
Boring Drilled By: Name of crew chief (first, last) and Firm First Name: Last Name:			Date Drilling Started m m / d d / y y y y	Date Drilling Completed m m / d d / y y y y	Drilling Method	
Firm:						
WI Unique Well No.	DNR Well ID No.	Well Name	Final Static Water Level ____ Feet MSL	Surface Elevation ____ Feet MSL	Borehole Diameter ____ inches	
Local Grid Origin <input type="checkbox"/> (estimated: <input type="checkbox"/> ) or Boring Location <input type="checkbox"/> State Plane _____ N, _____ E			Lat _____ ° ' " _____ ° ' "		Local Grid Location <input type="checkbox"/> N <input type="checkbox"/> E <input type="checkbox"/> S <input type="checkbox"/> W	
1/4 of _____ 1/4 of Section _____, T _____ N, R _____			Long _____ ° ' "		Feet _____ Feet _____	
Facility ID	County	County Code	Civil Town/City/ or Village			

[illegible]

Signature	Firm
-----------	------

This form is authorized by Chapters 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats. Completion of this form is mandatory. Failure to file this form may result in forfeiture of between \$10 and \$25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. NOTE: See instructions for more information, including where the completed form should be sent.

[illegible]

Route to: Watershed/Wastewater ☐ Waste Management ☐  
Remediation/Redevelopment ☐ Other ☐

MONITORING WELL CONSTRUCTION  
Form 4400-113A Rev. 7-98

Facility/Project Name	Local Grid Location of Well ft. <input type="checkbox"/> N. <input type="checkbox"/> E. ft. <input type="checkbox"/> S. <input type="checkbox"/> W.		Well Name
Facility License, Permit or Monitoring No.	Local Grid Origin <input type="checkbox"/> (estimated: <input type="checkbox"/> ) or Well Location <input type="checkbox"/> Lat. _____ Long. _____ or _____		Wis. Unique Well No. DNR Well ID No.
Facility ID	St. Plane _____ ft. N. _____ ft. E. S/C/N		Date Well Installed m m d d y y y y
Type of Well	Section Location of Waste/Source 1/4 of _____ 1/4 of Sec. _____ T. _____ N. R. <input type="checkbox"/> E <input type="checkbox"/> W		Well Installed By: Name (first, last) and Firm
Well Code _____ / _____	Location of Well Relative to Waste/Source u <input type="checkbox"/> Upgradient s <input type="checkbox"/> Sidegradient d <input type="checkbox"/> Downgradient n <input type="checkbox"/> Not Known		Gov. Lot Number
Distance from Waste/Source _____ ft.	Enf. Stds. Apply <input type="checkbox"/>		

A. Protective pipe, top elevation _____ ft. MSL	1. Cap and lock? <input type="checkbox"/> Yes <input type="checkbox"/> No
B. Well casing, top elevation _____ ft. MSL	2. Protective cover pipe: a. Inside diameter: _____ in. b. Length: _____ ft. c. Material: Steel <input type="checkbox"/> 04 Other <input type="checkbox"/>
C. Land surface elevation _____ ft. MSL	d. Additional protection? <input type="checkbox"/> Yes <input type="checkbox"/> No If yes, describe: _____
D. Surface seal, bottom _____ ft. MSL or _____ ft.	3. Surface seal: Bentonite <input type="checkbox"/> 30 Concrete <input type="checkbox"/> 01 Other <input type="checkbox"/>
12. USCS classification of soil near screen: GP <input type="checkbox"/> GM <input type="checkbox"/> GC <input type="checkbox"/> GW <input type="checkbox"/> SW <input type="checkbox"/> SP <input type="checkbox"/> SM <input type="checkbox"/> SC <input type="checkbox"/> ML <input type="checkbox"/> MH <input type="checkbox"/> CL <input type="checkbox"/> CH <input type="checkbox"/> Bedrock <input type="checkbox"/>	
13. Sieve analysis performed? <input type="checkbox"/> Yes <input type="checkbox"/> No	4. Material between well casing and protective pipe: Bentonite <input type="checkbox"/> 30 Other <input type="checkbox"/>
14. Drilling method used: Rotary <input type="checkbox"/> 50 Hollow Stem Auger <input type="checkbox"/> 41 Other <input type="checkbox"/>	5. Annular space seal: a. Granular/Chipped Bentonite <input type="checkbox"/> 33 b. _____ Lbs/gal mud weight ... Bentonite-sand slurry <input type="checkbox"/> 35 c. _____ Lbs/gal mud weight ... Bentonite slurry <input type="checkbox"/> 31 d. _____ % Bentonite ... Bentonite-cement grout <input type="checkbox"/> 50 e. _____ Ft <sup>3</sup> volume added for any of the above f. How installed: Tremie <input type="checkbox"/> 01 Tremie pumped <input type="checkbox"/> 02 Gravity <input type="checkbox"/> 08
15. Drilling fluid used: Water <input type="checkbox"/> 02 Air <input type="checkbox"/> 01 Drilling Mud <input type="checkbox"/> 03 None <input type="checkbox"/> 99	6. Bentonite seal: a. Bentonite granules <input type="checkbox"/> 33 b. <input type="checkbox"/> 1/4 in. <input type="checkbox"/> 3/8 in. <input type="checkbox"/> 1/2 in. Bentonite chips <input type="checkbox"/> 32 c. _____ Other <input type="checkbox"/>
16. Drilling additives used? <input type="checkbox"/> Yes <input type="checkbox"/> No	7. Fine sand material: Manufacturer, product name & mesh size a. _____ b. Volume added _____ ft <sup>3</sup>
Describe _____	8. Filter pack material: Manufacturer, product name & mesh size a. _____ b. Volume added _____ ft <sup>3</sup>
17. Source of water (attach analysis, if required): _____	9. Well casing: Flush threaded PVC schedule 40 <input type="checkbox"/> 23 Flush threaded PVC schedule 80 <input type="checkbox"/> 24 Other <input type="checkbox"/>
E. Bentonite seal, top _____ ft. MSL or _____ ft.	10. Screen material: a. Screen type: Factory cut <input type="checkbox"/> 11 Continuous slot <input type="checkbox"/> 01 Other <input type="checkbox"/>
F. Fine sand, top _____ ft. MSL or _____ ft.	b. Manufacturer _____
G. Filter pack, top _____ ft. MSL or _____ ft.	c. Slot size: _____ in.
H. Screen joint, top _____ ft. MSL or _____ ft.	d. Slotted length: _____ ft.
I. Well bottom _____ ft. MSL or _____ ft.	11. Backfill material (below filter pack): None <input type="checkbox"/> 14 Other <input type="checkbox"/>
J. Filter pack, bottom _____ ft. MSL or _____ ft.	
K. Borehole, bottom _____ ft. MSL or _____ ft.	
L. Borehole, diameter _____ in.	
M. O.D. well casing _____ in.	
N. I.D. well casing _____ in.	

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature

Firm

Route to: Watershed/Wastewater ☐ Waste Management ☐  
Remediation/Redevelopment ☐ Other ☐

Facility/Project Name	County Name	Well Name
Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number
		DNR Well ID Number

1. Can this well be purged dry? ☐ Yes ☐ No

2. Well development method

- surged with bailer and bailed ☐ 41  
 surged with bailer and pumped ☐ 61  
 surged with block and bailed ☐ 42  
 surged with block and pumped ☐ 62  
 surged with block, bailed and pumped ☐ 70  
 compressed air ☐ 20  
 bailed only ☐ 10  
 pumped only ☐ 51  
 pumped slowly ☐ 50  
 Other ☐

3. Time spent developing well \_\_\_\_\_ min.

4. Depth of well (from top of well casing) \_\_\_\_\_ ft.

5. Inside diameter of well \_\_\_\_\_ in.

6. Volume of water in filter pack and well casing \_\_\_\_\_ gal.

7. Volume of water removed from well \_\_\_\_\_ gal.

8. Volume of water added (if any) \_\_\_\_\_ gal.

9. Source of water added \_\_\_\_\_

10. Analysis performed on water added? ☐ Yes ☐ No  
(If yes, attach results)

17. Additional comments on development:

11. Depth to Water (from top of well casing)

	Before Development	After Development
a. _____ ft.	_____ ft.	
Date	b. ____/____/____	____/____/____
	m m / d d / y y y y	m m / d d / y y y y
Time	c. ____:____ <input type="checkbox"/> a.m. <input type="checkbox"/> p.m.	____:____ <input type="checkbox"/> a.m. <input type="checkbox"/> p.m.

12. Sediment in well bottom \_\_\_\_\_ inches \_\_\_\_\_ inches

13. Water clarity Clear ☐ 10 Turbid ☐ 15 (Describe) \_\_\_\_\_  
Clear ☐ 20 Turbid ☐ 25 (Describe) \_\_\_\_\_

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids \_\_\_\_\_ mg/l \_\_\_\_\_ mg/l

15. COD \_\_\_\_\_ mg/l \_\_\_\_\_ mg/l

16. Well developed by: Name (first, last) and Firm

First Name: \_\_\_\_\_ Last Name: \_\_\_\_\_

Firm: \_\_\_\_\_

Name and Address of Facility Contact /Owner/Responsible Party

First Name: \_\_\_\_\_ Last Name: \_\_\_\_\_

Facility/Firm: \_\_\_\_\_

Street: \_\_\_\_\_

City/State/Zip: \_\_\_\_\_

I hereby certify that the above information is true and correct to the best of my knowledge.

Signature: \_\_\_\_\_

Print Name: \_\_\_\_\_

Firm: \_\_\_\_\_

NOTE: See instructions for more information including a list of county codes and well type codes.

Notice: Please complete Form 3300-5 and return it to the appropriate DNR office and bureau. Completion of this report is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file this form may result in a forfeiture of between \$10 and \$25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. NOTE: See the instructions for more information.

Route to: ☐ Drinking Water ☐ Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☐ Other \_\_\_\_\_

(1) GENERAL INFORMATION			(2) FACILITY/ OWNER INFORMATION	
WI Unique Well No. _____	DNR Well ID No. _____	County _____	Facility Name _____	
Common Well Name _____ Gov't Lot (If applicable) _____			Facility ID _____	License/Permit/Monitoring No. _____
_____ 1/4 of _____ 1/4 of Sec. _____ ; T. _____ N; R. _____			Street Address of Well _____	
Grid Location _____ ft. <input type="checkbox"/> N. <input type="checkbox"/> S. _____ ft. <input type="checkbox"/> E. <input type="checkbox"/> W.			City, Village, or Town _____	
Local Grid Origin <input type="checkbox"/> (estimated: <input type="checkbox"/> ) or Well Location <input type="checkbox"/>			Present Well Owner _____ Original Owner _____	
Lat. _____ Long. _____ or _____			Street Address or Route of Owner _____	
St. Plane _____ ft. N. _____ ft. E. <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Zone _____			City, State, Zip Code _____	
Reason For Abandonment _____ WI Unique Well No. _____ of Replacement Well _____				

(3) WELL/DRILLHOLE/BOREHOLE INFORMATION	(4) PUMP, LINER, SCREEN, CASING, & SEALING MATERIAL				
Original Construction Date _____ <input type="checkbox"/> Monitoring Well <input type="checkbox"/> Water Well <input type="checkbox"/> Borehole / Drillhole Construction Type: <input type="checkbox"/> Drilled <input type="checkbox"/> Driven (Sandpoint) <input type="checkbox"/> Dug <input type="checkbox"/> Other (Specify) _____ Formation Type: <input type="checkbox"/> Unconsolidated Formation <input type="checkbox"/> Bedrock Total Well Depth (ft.) _____ Casing Diameter (in.) _____ (From ground surface) Casing Depth (ft.) _____ Lower Drillhole Diameter (in.) _____ Was Well Annular Space Grouted? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Unknown If Yes, To What Depth? _____ Feet Depth to Water (Feet) _____	Pump & Piping Removed? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not Applicable Liner(s) Removed? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not Applicable Screen Removed? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not Applicable Casing Left in Place? <input type="checkbox"/> Yes <input type="checkbox"/> No Was Casing Cut Off Below Surface? <input type="checkbox"/> Yes <input type="checkbox"/> No Did Sealing Material Rise to Surface? <input type="checkbox"/> Yes <input type="checkbox"/> No Did Material Settle After 24 Hours? <input type="checkbox"/> Yes <input type="checkbox"/> No If Yes, Was Hole Retopped? <input type="checkbox"/> Yes <input type="checkbox"/> No Required Method of Placing Sealing Material <input type="checkbox"/> Conductor Pipe-Gravity <input type="checkbox"/> Conductor Pipe-Pumped <input type="checkbox"/> Screened & Poured (Bentonite Chips) <input type="checkbox"/> Other (Explain) _____ <table style="width:100%;"> <tr> <th style="text-align: left;">Sealing Materials</th> <th style="text-align: left;">For monitoring wells and monitoring well boreholes only</th> </tr> <tr> <td> <input type="checkbox"/> Neat Cement Grout  <input type="checkbox"/> Sand-Cement (Concrete) Grout  <input type="checkbox"/> Concrete  <input type="checkbox"/> Clay-Sand Slurry (11 lb./gal. wt.)  <input type="checkbox"/> Bentonite-Sand Slurry " "  <input type="checkbox"/> Bentonite Chips               </td> <td> <input type="checkbox"/> Bentonite Chips  <input type="checkbox"/> Granular Bentonite  <input type="checkbox"/> Bentonite - Cement Grout  <input type="checkbox"/> Bentonite - Sand Slurry               </td> </tr> </table>	Sealing Materials	For monitoring wells and monitoring well boreholes only	<input type="checkbox"/> Neat Cement Grout <input type="checkbox"/> Sand-Cement (Concrete) Grout <input type="checkbox"/> Concrete <input type="checkbox"/> Clay-Sand Slurry (11 lb./gal. wt.) <input type="checkbox"/> Bentonite-Sand Slurry " " <input type="checkbox"/> Bentonite Chips	<input type="checkbox"/> Bentonite Chips <input type="checkbox"/> Granular Bentonite <input type="checkbox"/> Bentonite - Cement Grout <input type="checkbox"/> Bentonite - Sand Slurry
Sealing Materials	For monitoring wells and monitoring well boreholes only				
<input type="checkbox"/> Neat Cement Grout <input type="checkbox"/> Sand-Cement (Concrete) Grout <input type="checkbox"/> Concrete <input type="checkbox"/> Clay-Sand Slurry (11 lb./gal. wt.) <input type="checkbox"/> Bentonite-Sand Slurry " " <input type="checkbox"/> Bentonite Chips	<input type="checkbox"/> Bentonite Chips <input type="checkbox"/> Granular Bentonite <input type="checkbox"/> Bentonite - Cement Grout <input type="checkbox"/> Bentonite - Sand Slurry				

(5) Material Used To Fill Well/Drillhole	From (Ft.)	To (Ft.)	No. Yards, Sacks Sealant or Volume	(Circle One)	Mix Ratio or Mud Weight
Surface					

(6) Comments: \_\_\_\_\_

(7) Name of Person or Firm Doing Sealing Work _____		Date of Abandonment _____	<b>FOR DNR OR COUNTY USE ONLY</b> <table border="1" style="width:100%; border-collapse: collapse;"> <tr> <td style="width:50%;">Date Received _____</td> <td style="width:50%;">Noted By _____</td> </tr> <tr> <td colspan="2">Comments _____</td> </tr> </table>		Date Received _____	Noted By _____	Comments _____	
Date Received _____	Noted By _____							
Comments _____								
Signature of Person Doing Work _____		Date Signed _____						
Street or Route _____	Telephone Number ( ) _____							
City, State, Zip Code _____								

**Standard Operating Procedure**

**For**

**Exploration Test Pits**

Prepared by: \_\_\_\_\_

Date: \_\_\_\_\_

Reviewed by: \_\_\_\_\_

Date: \_\_\_\_\_

Approved by: \_\_\_\_\_

Date: \_\_\_\_\_

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## **1.0 SCOPE**

This standard operating procedure (SOP) describes the procedures to be followed during the excavation, logging, and sampling of test pits. Test pits will be advanced using heavy equipment (excavator).

## **2.0 OBJECTIVES**

- Use safe methods to advance excavations to properly characterize site conditions.
- Describe the physical nature of unconsolidated subsurface materials.
- Characterize disposal areas and describe waste materials.
- Serve as a means to allow traceability of error(s) in sampling and data recording.

## **2.0 EQUIPMENT NEEDED**

- Waterproof and permanent marker;
- Field notebook;
- Field forms such as chain of custody, boring logs, and air monitoring logs as required by the HSP;
- Sample jars and labels;
- Visqueen or plastic sheeting;
- Metal shovel;
- Appropriate health and safety equipment as required by the HSP;
- Measuring tape;
- PID or FID;
- Appropriate decontamination equipment as required by SOPs 190 and 220
- Camera;
- Survey lathe, tape, and marking paint;
- Traffic cones and caution tape; and
- Construction fencing and fencepost.

## **3.0 PROCEDURES FOR ADVANCING EXCAVATION TEST PITS**

### **3.1 Prior to Mobilization**

Field Managers should meet with the Project Manager to discuss requirements for test pit activities. These requirements include:

1. Review of work plan or sampling plan to determine the number and location of the proposed test pits.
2. Identify air monitoring equipment required by the site specific HSP.
3. Contact Digger's Hotline to identify buried utilities. Contact site representative to review documentation available regarding potential buried utilities located at the site or confirm utility clearance.
4. Schedule field activities with selected subcontractor. Identify proposed excavation equipment to be used and review proposed scope of work with subcontractor.

### **3.2 Test Pit Procedures**

Before advancing a test pit, Field Managers should:

1. Identify and locate proposed test pit locations. Delineate limits of excavation using spray paint or survey lathe and tape.
2. Confirm that buried utilities are not identified at the proposed test pit locations. Contact the Project Manager to discuss alternative locations if buried utilities are identified at a proposed test pit location.
3. Confirm that excavating equipment has been decontaminated.
4. Secure exclusion zone with construction fencing and fenceposts prior to advancing test pits.
5. Set up and/or calibrate air monitoring equipment. Review the HSP to identify site specific monitoring requirements and applicable action levels.

Once these pre-excavation activities have occurred, test pit activities can commence. The excavator should have a smooth edged bucket 2 to 3 feet wide. Procedures for advancing test pits are as follows:

1. Remove and stockpile topsoil for later use. This material should be stockpiled separately from other excavated soils.
2. Lay visqueen or plastic sheeting on the downslope side of the trench and secure with stakes or weights. The excavated sub-soils will be stockpiled on the visqueen.
3. Make shallow cuts of 6 inches to 1 foot and stockpile excavation spoils on the visqueen.
4. The site geologist should observe the trench at a safe distance. Notify the excavator operator and make eye contact prior to entering the swing radius of the equipment.
5. Sketch the development of the test pit in the field notebook. Complete vertical profiles at multiple locations along the length of the test pit. Sketch a cross section of the longitudinal length of the test pit.
6. Record physical characteristics of the material excavated including, USCS soil type, lithology, color, odor, moisture, and foreign objects in the field notebook. Photodocument observations as appropriate. Reference photos in the field logbook.
7. Once excavation is complete, record the depth, length, and width of the excavation in the field notebook.
8. Backfill the test pit with the material excavated. Replace the material in one-foot lifts in the reverse order from which it was removed. Compact the material after replacement of each lift.
9. Test pits must be backfilled at the end of each work day and are not to remain open overnight.

**3.3 Decontamination**

All tools and sampling equipment will be decontaminated in accordance with SOP 190 and SOP 220 between test pit locations.

**Standard Operating Procedure**  
**For**  
**Soil Sample Collection**

Prepared by: \_\_\_\_\_

Date: \_\_\_\_\_

Reviewed by: \_\_\_\_\_

Date: \_\_\_\_\_

Approved by: \_\_\_\_\_

Date: \_\_\_\_\_

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## **1.0 SCOPE**

This standard operating procedure (SOP) describes the steps for collection of representative soil samples from surface or subsurface locations. Surface soil samples will be manually collected using either a shovel or hand auger. Subsurface soil samples will be collected using either direct-push drilling (Geoprobe) methods or in the case of exploration test pits, an excavator.

## **2.0 OBJECTIVES**

- Ensure that the representative soil samples will be collected to properly characterize site conditions.
- Use consistent methods that reduce potential for cross contamination and avoid introducing contamination as a result of poor sampling and/or handling technique.
- Serve as a means to allow traceability of error(s) in sampling and data recording.

## **2.0 EQUIPMENT NEEDED**

- Waterproof and permanent marker;
- Field notebook
- Field forms such as chain of custody, boring logs, and air monitoring logs as required by the HSP;
- Sample jars and labels;
- Appropriate health and safety equipment as required by the HSP;
- Measuring tape;
- PID or FID;
- Ziplock storage bags;
- Stainless steel bowls and spoons;
- Hand auger, shovel, or trowels ;
- Aluminum Foil;
- Laboratory supplied sample jars and preservatives;
- Coolers and ice; and
- Appropriate decontamination equipment as required by SOP 190;

## **3.0 SURFACE SOIL SAMPLE COLLECTION PROCEDURES**

### **3.1 Sampling Locations**

All boreholes will be horizontally located by measurements to fixed structures or reference points on the site. Locations will be marked with a stake, flag, or paint, and utilities will be cleared through Digger's Hotline prior to drilling.

### **3.2 Sample Collection Procedures**

The following steps describe the procedures used to collect surface soil samples:

1. Decontaminate sampling equipment according to SOP 190.
2. Clear and remove vegetation and any surface debris such as rocks.
3. Don a clean pair of rubber or surgical gloves and the appropriate level of protection as specified in the HASP.
4. Collect the sample from the top six inches of soil using a decontaminated hand auger, shovel or trowel.
5. If the sample is to be analyzed for volatile organics, collect a representative sample from the bottom 3 inches of soil and place it directly into the laboratory supplied bottle.
6. Homogenize the remainder of the sample in the hole and fill the remainder of the lab jars for sample analysis.
7. Replace the vegetative mat over the disturbed area.
8. Label, pack, and preserve samples according to SOP 160.
9. Record applicable information on the sample collection log.
10. Record the sample location on a site map.

### **3.3 Decontamination**

All tools and sampling equipment will be decontaminated in accordance with SOP 190 between sample locations.

## **4.0 SUBSURFACE SOIL SAMPLE COLLECTION PROCEDURES**

### **4.1 Sampling Locations**

All boreholes will be horizontally located by measurements to fixed structures or reference points on the site. Locations will be marked with a stake, flag, or paint, and utilities will be cleared through Digger's Hotline prior to drilling.

### **4.2 Methods of Collection**

Subsurface soil samples will be collected from either cores advanced by a direct push (Geoprobe) drill rig or from soils extracted from exploratory test pits with an excavator.

### **4.3 Direct Push Drilling**

Samples will be collected continuously with a Geoprobe macro sampler. The macro sampler is a core sampler that is advanced by a solid rod with the Geoprobe. For each sample, a clear plastic liner will be placed in the macro sampler. The soil sample within the plastic liner will be extracted from the macro sampler, and examined by the URS field manager. Soil units will be visually classified in accordance with the Unified Soil Classification System (USCS), and recorded on a field boring log. In areas where volatile compounds are suspected or encountered, soil samples will be screened as needed with a photoionization detector, and readings will be recorded on the boring log. SOP 260 describes procedures for field screening.

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**4.4 Exploration Test Pits**

Samples will be collected from each test pit. As material is excavated from the test pit, a sample will be collected either from the excavator bucket or from the stockpile of excavated material, placed in a ziplock bag, and examined by the URS field manager. Soil units will be visually classified in accordance with the Unified Soil Classification System (USCS), and recorded on a field boring log. In areas where volatile compounds are suspected or encountered, soil samples will be screened as needed with a photoionization detector, and readings will be recorded on the boring log. SOP 260 describes procedures for field screening.

**4.5 Sample Collection Procedures**

Representative soil samples will be collected for laboratory analysis based on visual observation and field screening results. In accordance with SOP 160, each soil sample will be collected by placing soil in laboratory provided containers. Samples selected for VOC analysis, will be collected by placing 25 to 35 grams of in a 60 mL glass jar. The sample will then be preserved by adding 25 mL of methanol. All samples selected for VOC analysis will be preserved with methanol within 2 hours of sample collection. Samples selected for percent solids and metals analysis will be placed in a single plastic bottle provided by the laboratory, and filled (zero head space).

**4.6 Decontamination**

All down hole drilling tools and sampling equipment will be decontaminated in accordance with SOP 190 between boring locations.

**4.7 Borehole Abandonment**

Following soil and groundwater sample collection, all borings will be abandoned in accordance with NR 141 requirements. SOP 120 describes procedures for borehole abandonment. Each well will be backfilled with granular bentonite. (The temporary well casing and screen will be removed from boreholes from which groundwater samples were obtained.) The volume of material used to backfill each borehole will be recorded on well abandonment forms (WDNR Form 3300-5P). Concrete or asphalt will be patched as needed.



**Standard Operating Procedure**  
**For**  
**Groundwater Sample Collection**

Prepared by: \_\_\_\_\_

Date: \_\_\_\_\_

Reviewed by: \_\_\_\_\_

Date: \_\_\_\_\_

Approved by: \_\_\_\_\_

Date: \_\_\_\_\_

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**Attachments**

FORM 150-A Groundwater Sampling Record

## **1.0 SCOPE**

This operating procedure describes steps involved in well purging and preparation for taking groundwater samples using a bailer and its accessory equipment. Dedicated sampling equipment is to be used whenever possible to prevent cross-contamination between sampling points. Manufacturer's specifications and recommendations for all equipment should be followed.

## **2.0 OBJECTIVES**

The activities covered by this procedure:

- Insure that the groundwater samples taken will be representative of actual groundwater quality.
- Insure quality control and consistency in taking samples.
- Serve as a means to allow traceability of error(s) in sampling and data recording.

## **3.0 EQUIPMENT NEEDED**

- Well keys;
- Waterproof and permanent marker;
- Field notebook and sample collection forms;
- Sample jars and labels;
- Bailer constructed of Teflon®, stainless steel, or PVC pipe;
- Nylon rope;
- Bulk storage tank or drum for storing purged water;
- Appropriate health and safety equipment;
- 12 volt submersible whale pump;
- A tarp or plastic sheet to cover ground and to lay bailer, line, reel, and water level tape;
- Water quality Meter;
- Calculator;
- Appropriate decontamination equipment;
- A water level measuring tape; and
- Spare batteries for field instruments.

## **4.0 PRELIMINARY TO OPERATION**

1. Review project work plan for site-specific sampling requirements and procedures.
2. The bailer, reel, line, water level measuring tape, thermometer, pH and conductivity meters should be cleaned, checked for defects, and any possible need for repair.
3. Batteries should be checked in the water quality meter (SOP 110) and calculator.
4. A decontaminated tarp or plastic sheet should be placed on the ground for the bailer, reel, line, water level measuring tape and other equipment to be placed.

**5.0 OPERATING PROCEDURE**

Procedures for collecting groundwater samples from monitoring wells are as follows:

1. Place tarp around well by cutting a slit in the tarp and lowering it around the protective casing.
2. Record the well number, time, and date and all pertinent information and data on groundwater sampling record, or other data sheet or field logbook.
3. Identify measuring point, marked on well casing. Following the procedures outlined in SOP 100, measure the depth to groundwater in the well to the nearest 0.01 foot with water level tape. Measure depth to the bottom of the well to the nearest 0.01 foot with a weighted tape. Enter these data on the groundwater sampling record. Decontaminate the water level tape and weighted tape measure following water level measurement.

$$Volume (gallons) = \pi \times H \times \left(\frac{D}{24}\right)^2 \times \frac{7.48 \text{ gal}}{ft^3}$$

4. Calculate the volume of water in the well using the equation:  
  
Where: H = Depth of Well minus Depth to Water (feet); and  
D = Inside diameter of well (inches).
5. If a bailer is used for well purging, lower the bailer in the well to just below the water level and retrieve when filled.
6. If a pump is used for well purging, lower pump or intake into the well to a distance just below the water level and begin water removal. Measure rate of discharge frequently to ensure required volume is removed.
7. Place purge water in bulk storage container for disposal. Purge water should be disposed of in accordance with the Investigative Derived Waste management plan.
8. Continue purging the well until at least four times the volume calculated in Step No. 4 has been removed. For low permeability formations, continue purging until the well is dry. If purged dry, allow the well to recover completely and purge dry a second time. Record the actual volume of water purged and note whether the well was bailed dry on the sampling record or in the field logbook.
9. Allow water level to recover sufficiently so that an adequate volume of water for the intended analyses is present. It is not necessary for the water level to return to its original level.
10. Remove one bail of water from the well and record its temperature, pH, conductivity, and dissolved oxygen content. Record the measurements and the time.

11. Begin removing sample bails with the bailer and line. Use the first bail for VOC analysis and pour into bottle using care not to stir and allowing air bubbles to escape. Use last bail for metals analysis. Filter groundwater samples per SOP 170 for dissolved metals analyses. Required sample containers and preservative requirements are discussed in the project work plan. Between removing bails, do not lay bailer or line on the ground unless it is covered with a new or decontaminated tarp or plastic sheet.
12. Affix labels to each sample bottle recording sample number, well number, date, and time. Place clear tape over the label and secure the lid of the sample container with shipping tape.
13. Record sample information on sampling record or in field log, along with a description of the physical appearance of the sample, including color, odor, and turbidity.
14. Place samples immediately in a shipping container maintained at 4°C.
15. Decontaminate electric water level tape, as described in SOP 190.

# FORM 150A

## GROUNDWATER SAMPLING RECORD

SITE NAME: Ashland/NSP Lakefront Site  
 PROJECT NO.: 25688375.60000  
 DATE: \_\_\_\_\_

WELL NO.: \_\_\_\_\_  
 SAMPLERS: \_\_\_\_\_  
 PURGE TIME: \_\_\_\_\_

## WATER QUALITY OBSERVATIONS

WELL DIAMETER: 2-in.  
 TOC ELEVATION: \_\_\_\_\_  
 GW ELEV.: \_\_\_\_\_

DEPTH OF WELL: \_\_\_\_\_  
 DEPTH OF WATER: \_\_\_\_\_  
 WATER COLUMN: \_\_\_\_\_

## WELL DATA

WELL DIA. 2"  
 VOLUME 0.163 gal./ft.

### PURGING METHOD

BAILER

PUMP

WATER QUALITY		WELL CONDITION	
COLOR		LOCK	
ODOR		CAP	
TURBIDITY		PROTOP	

### INFORMATION

PURGE VOLUME  
 TO PURGE: \_\_\_\_\_ gallons  
 ACT. PURGED: \_\_\_\_\_ gallons  
 PURGED DRY? \_\_\_\_\_  
 FLOW RATE? \_\_\_\_\_  
 DTW AFTER PURGING \_\_\_\_\_  
 PROBLEMS \_\_\_\_\_

## ANALYSIS DATA

TIME/GALLONS				
pH				
CONDUCTIVITY				
TEMPERATURE				
DISS. OXYGEN				
TURBIDITY				

## ANALYSIS DATA CONTINUED

VOLUME/CONTAINER	ANALYSIS / PRESERVATIVE	FILTERED	TIME
3 - 40 ml vials	VOC 8260B / HCl	no	
2 - 1 L amber	SVOC 8270C/ none	no	
1 - 250 ml plastic	Tot. Cn / NaOH	no	
1 - 250 ml plastic	Tot. Metals / HNO3	no	
1 - 250 ml plastic	Diss. Metals / HNO3	yes	
1 - 250 ml plastic	Chromium (+6) / none	yes	

## ANALYSIS DATA CONTINUED

**Standard Operating Procedure**  
**For**  
**VOC, SVOC, and Inorganic Sample Collection**

Prepared by: \_\_\_\_\_

Date: \_\_\_\_\_

Reviewed by: \_\_\_\_\_

Date: \_\_\_\_\_

Approved by: \_\_\_\_\_

Date: \_\_\_\_\_

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## **1.0 SCOPE**

This procedure describes the methods that will be used to collect soil, sediment and groundwater samples for VOCs, SVOCs, and inorganic compounds.

## **2.0 OBJECTIVES**

The activities covered by this procedure:

- Insure quality control in field sampling for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and inorganic compounds (cyanide).
- Insure uniformity and continuity in sampling techniques and use of the equipment by different qualified field samplers or technicians.
- Serve as a means to allow traceability of error(s) in sampling.

## **3.0 EQUIPMENT NEEDED**

- PPE as required in HSP;
- Laboratory supplied sample containers;
- Labels and chains of custody;
- Scale;
- Spatula;
- Distilled or de-ionized water;
- Paper towels;
- Coolers with ice; and
- Waterproof marking pen or pencil.

## **4.0 OPERATING PROCEDURE**

### **4.1 Water Samples**

Water and surface water sample collection for VOC, SVOCs, and inorganic compounds consists of the following steps:

1. Fill VOC vials first. Remove cap of vial just prior to sampling.
2. Hold cap in same hand as the bottle.
3. For VOC water samples, tilt vial slightly into water and fill slowly to minimize the turbulence and aeration. Bailer bottom emptying device is recommended.
4. For VOC water samples, fill vial ensuring that a positive meniscus is formed. Vials should not be overfilled as loss of HCl preservative may result. Place cap on top of septum and quickly screw it on tightly.
5. If bubbles are present in VOC water samples, discard the sample and begin over with a new set of vials. If no bubbles are present, label and mark it with project number, description,

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sample number, sampler's initials, date and time of sampling, etc., with a waterproof marker.

6. For SVOCs and inorganic compound samples, remove lids of plastic laboratory supplied bottles just prior to sample collection.
7. Tilt bottle into water and fill slowly to minimize the turbulence and aeration. Bailer bottom emptying device is recommended. Follow procedures in SOP 170 for field filtering. Place lid on bottle. Label and mark it with project number, description, sample number, sampler's initials, date and time of sampling, etc., with a waterproof marker.
8. Wash outside of vials and bottles with distilled or organic free water and wipe clean with a paper towel.
9. Store in ice-packed sample container and ship with a chain-of-custody record.

#### **4.2 Soil/Sediment Samples**

Soil and sediment sample collection for VOC, SVOCs, and inorganic compounds consists of the following steps:

1. Fill VOC jars first. Remove cap of vial just prior to sampling. Place jar on field scale to obtain tare weight.
2. Place 25 to 35 grams of soil in VOC jar using spatula as needed. The weight of the soil added to the jar will be recorded in the field notes and on the sample label.
3. Add 25 mL of methanol to preserve sample. Place lid on bottle. Label and mark it with project number, description, sample number, sampler's initials, date and time of sampling, etc., with a waterproof marker.
4. For SVOC and inorganic compound samples, remove lids of plastic or glass laboratory supplied bottles just prior to sample collection.
5. Fill bottle with soil (zero head space). Place lid on bottle. Label and mark it with project number, description, sample number, sampler's initials, date and time of sampling, etc., with a waterproof marker.
6. Wash outside of vials and bottles with distilled or organic free water and wipe clean with a paper towel.
7. Store in ice-packed sample container and ship with a chain-of-custody record.

**Standard Operating Procedure**  
**For**  
**Field Filtering Groundwater Samples**

Prepared by: \_\_\_\_\_

Date: \_\_\_\_\_

Reviewed by: \_\_\_\_\_

Date: \_\_\_\_\_

Approved by: \_\_\_\_\_

Date: \_\_\_\_\_



FIELD FILTERING GROUNDWATER SAMPLES

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## **1.0 SCOPE**

This procedure describes the methods for filtering suspended particulates from groundwater samples for metals analyses.

## **2.0 OBJECTIVES**

The activities covered by this procedure:

- Insure quality control in filtering of groundwater samples for analysis of dissolved metals.
- Insure uniformity and continuity in sampling techniques and use of the equipment by different qualified field samplers or technicians.
- Serve as a means to allow traceability of error(s) in sampling.

## **3.0 EQUIPMENT NEEDED**

- Field Notebook;
- Peristaltic pump and tubing;
- Disposable 0.45 micron in-line filter;
- Transfer bottle;
- Labels and sample bottles;
- Distilled or de-ionized water; and
- Waterproof marking pen or pencil.

## **4.0 PROCEDURE**

Field filtering groundwater for metals analysis will consist of the following steps:

1. Inspect filtering equipment and filters for cleanliness and defects, and need for repair.
2. Obtain groundwater sample and fill a decontaminated transfer bottle or container.
3. Using peristaltic pump, pump water from transfer bottle through the in-line 0.045 micron filter, and discharge to laboratory supplied container.
4. Filter groundwater samples within 15 minutes of sample collection.
5. Record sample information of laboratory chain of custody.

**Standard Operating Procedure**  
**For**  
**QualityControl Sampling**

Prepared by: \_\_\_\_\_

Date: \_\_\_\_\_

Reviewed by: \_\_\_\_\_

Date: \_\_\_\_\_

Approved by: \_\_\_\_\_

Date: \_\_\_\_\_

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## **1.0 SCOPE**

This Standard operating procedure (SOP) describes the type and quantity of Quality Control (QC) samples to be collected for most field sampling operations. QC samples are those samples (usually collected in the field) that are sent to the laboratory along with the environmental samples in order to evaluate site conditions and laboratory precision and accuracy. Evaluation of the results from the QC samples allows for the quality of the data to be assessed. There are five different types of QC samples: trip blanks, equipment rinsate blanks, field blanks, duplicates and matrix spike/matrix spike duplicate (MS/MSD) samples. The first three types of QC samples are used to assess field conditions during sampling and/or transport of the environmental samples. The latter two types of QC samples are used by the laboratory to help assess precision and accuracy. (The laboratory also has other internal samples and procedures to assess precision and accuracy.)

Depending on the Level of data quality required by the project, different amounts of QC samples are collected. These are described in detail below.

## **2.0 OBJECTIVES**

- Insure quality control in field sampling operations.
- Serve as a means to detect contamination that may result from sampling procedures.
- Provide documentation of equipment decontamination procedures.

## **3.0 DEFINITIONS**

Trip Blank - Trip blanks are 40-ml volatile organic analysis (VOA) vials of ASTM Type II water that are filled at the laboratory, transported to the sampling site, and returned to the laboratory with environmental VOA samples. Trip blanks are not opened in the field.

Equipment Rinsates - Equipment rinsates are samples of ASTM Type II water (provided by the laboratory) passed over decontaminated sampling equipment. They are used as a measure of the effectiveness of the decontamination procedure. The rinsate is analyzed for the same parameters as the environmental samples collected from the piece of equipment.

Field Blanks - Field blanks are samples of source water used for decontamination and steam cleaning. At a minimum there is one sample collected for each source of water used per sampling event. The field blank is analyzed for all the parameters tested during the sampling event.

Duplicates - Duplicates are collected to help assess laboratory reproducibility (precision). Solid matrix samples are homogenized before being split, except for VOAs, which are not homogenized because of potential volatile loss. Liquid matrix samples are collected simultaneously. For both solid and liquid matrices, double the normal volume is required. The same analyses are completed on the duplicate as on the environmental sample.

MS/MSD - MS/MSD samples are used by the laboratory (but collected in the field) to help determine both precision and accuracy of analysis. For liquid matrices, triple the volume of sample is required (that is, one volume for the environmental sample, one volume for the MS sample, and one volume for the MSD sample). For solid matrices, additional volume is usually not required (although this will depend upon the laboratory).



#### **4.0 RESPONSIBILITIES**

The Project Manager is responsible for estimating the number of QC samples required for any sampling event. The procedures for determining the number is described in Section 5.0 below. The Field Manager is responsible for making sure that the sampling team(s) are collecting the required number of QC samples. The Field Team member(s) are responsible for understanding the rationale and methods for QC sample collection and for coordinating QC sample collection as appropriate.

#### **5.0 PROCEDURES**

The procedures for QC sample collection and the frequency at which each type of sample should be collected is described below.

##### **5.1 Trip Blanks**

Trip blanks (one pair of 40 ml vials) are sent to the laboratory in each cooler which contains samples for volatile organic analyses. The trip blank should also be kept in the field, with the volatile samples, during the period of sample collection. Analyses of the trip blank will determine if the sample containers were contaminated prior to sampling or during transport.

##### **5.2 Equipment Rinsates**

Equipment rinsates are collected by pouring analyte-free water (provided by the laboratory) over decontaminated sampling equipment and collecting the rinsate. These are collected at a frequency of once per day and are analyzed for the same parameters as are the samples collected from that equipment. If two (or more) different types of equipment are used to collect samples in the same day (say by two field teams, one collecting soil samples from split spoons and one collecting groundwater from bailers), then two separate rinsate samples may be collected. The rinsate blank is used to qualify data.

##### **5.3 Field Blanks**

One field blank per source of water used for decontamination per sampling event is collected for all the parameters analyzed during that sampling event. In general, two field blanks are collected - one from the potable water source used for steam cleaning and one from distilled water purchased at a local store for use in general decontamination. The field blank is collected by opening up the water source at the sampling locations and pouring the water directly into the appropriate sample bottles. Analysis of the sample will indicate whether contamination was introduced into the samples during the collection process.

##### **5.4 Duplicates**

Field duplicates are collected at a frequency of 10 percent (one duplicate or per 10 samples) for levels C and D analyses, and at 5 percent (or one duplicate per 20 samples) for Level E analyses. The samples are split as described above and in other SOPs related to sample collection procedures. Field duplicates are primarily used to check the precision and consistency of the sampling procedures used and as a check of laboratory accuracy.

## **5.5 MS/MSD**

MS/MSD samples are collected in the same manner as for a duplicate sample, except that triple the volume is required for analysis (for liquids). Additional volume may be required by the laboratory for solid samples and should be verified with the lab prior to sample collection. The frequency of collection is one MS/MSD pair (or two additional sample volumes) for each 20 environmental samples collected of similar matrix (e.g. groundwater, surface water, soil). The number of MS/MSD samples to collect is determined as follows: 1-20 environmental samples, one MS/MSD pair; 21-40 environmental samples, two MS/MSD pairs, etc.

## **6.0 SAMPLE COLLECTION RECORDS AND EVALUATION**

Records of collection of QC samples are kept in the field logbooks and on the Chain-of-Custody forms. Evaluation of the results from the QC samples is performed by the laboratory and through data validation for the MS/MSD samples. Results of the other QC samples are compared to analytical results from the sampling event to determine if any field procedures, or sample transportation/handling may have adversely affected the concentrations found in the environmental samples.

## **7.0 REFERENCES**

Hazardous Waste Remedial Actions Program, 1990. Requirements for Quality Control of Analytical Data. DOE/HWP-65/R1, US Department of Energy, Oak Ridge, Tennessee.

Naval Energy and Environmental Support Activity, 1998. Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program. NEESA 20.2-047B, Port Hueneme, California.

USEPA, 1988. User's Guide to the Contract Laboratory Program. 9240.0-1, Office of Emergency and Remedial Response, Washington, D.C.

USEPA, 1990. Quality Assurance/Quality Control Guidance for Removal Activities - Sampling QA/QC Plan and Data Validation Procedures (Interim Final). EPA/540/G-90/004, Office of Emergency and Remedial Response, Washington, D.C.

**Standard Operating Procedure**  
**For**  
**Decontamination of Sampling Equipment**

Prepared by: \_\_\_\_\_

Date: \_\_\_\_\_

Reviewed by: \_\_\_\_\_

Date: \_\_\_\_\_

Approved by: \_\_\_\_\_

Date: \_\_\_\_\_

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4.0 PROCEDURE.....	3

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**1.0 SCOPE**

This operating procedure describes procedures used to decontaminate equipment used during environmental sampling of hazardous waste sites. Project-specific quality assurance objectives, provided in the project work plan and/or quality assurance plan, may override some of the procedure specified in the SOP.

**2.0 OBJECTIVES**

- Prevent cross-contamination between samples.
- Insure quality control in decontamination of field equipment used in sampling and handling environmental samples.
- Help to maintain a clean working environment for the safety of field personnel.
- Serve as a means to allow traceability of errors in procedures.

**3.0 EQUIPMENT NEEDED**

- Tap water and distilled water or de-ionized water;
- PPE as specified in the HSP;
- Five-gallon stainless steel pail and plastic bucket;
- Detergent (Alconox or Simple Green);
- Nylon scrub brush and long handled bottle brush;
- Aluminum foil and paper towels; and
- Trash receptacle.

**4.0 PROCEDURE**

1. Select an area of the site removed from sampling locations. If it can be determined, the area should be down gradient from wells being sampled.
2. Fill a 5-gallon pressurized sprayer or smaller squirt bottle with distilled water.
3. Wash all grit, grime, mud, particulates, etc., from the equipment being decontaminated with tap water and collect in a plastic bucket.
4. For equipment visibly contaminated with NAPL, use of a detergent such as Simple Green is recommended. In a bucket, wet the surface of the equipment with tap water and apply a 1:1 dilution of Simple Green to the affected area. Then, use a brush to break up NAPL deposits. Rinse with tap water to remove residual detergent. Proceed to step 5.
5. Put one gallon of distilled water into a 5-gallon stainless steel pail and add 1-cup of Alconox.
6. Wash equipment in the pail using a nylon scrub brush or long handled bottle brush.
7. Rinse all residual detergent from the equipment with the sprayer and collect rinsate.
8. Repeat steps 5 and 6 as necessary.

- 
9. Rinse the equipment thoroughly with organic free distilled water and collect the fluid in a plastic bucket.
  10. Dry and then wrap the equipment securely in aluminum foil or polyethylene sheeting.
  11. Dispose of soiled materials and fluids in designated disposal containers in accordance with the Investigative Derived Waste management plan. Use of a solvent rinse is not recommended because of safety and disposal concerns.

**Standard Operating Procedure**  
**For**  
**Summa Canister VOC Sample Collection**

Prepared by: \_\_\_\_\_

Date: \_\_\_\_\_

Reviewed by: \_\_\_\_\_

Date: \_\_\_\_\_

Approved by: \_\_\_\_\_

Date: \_\_\_\_\_

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**ATTACHMENTS****FORM 200-A CANISTER SAMPLING COLLECTION FORM**



## **1.0 SCOPE**

This standard operating procedure (SOP) describes the steps for sampling volatile organic compounds (VOCs) in soil vapor and indoor vapor intrusion using Summa passivated stainless steel canisters. Soil vapor samples will be collected from vapor probes described in Section 2.0 of the Field Sampling Plan (FSP). Vapor intrusion samples will be collected from indoor sampling locations described in Section 2.0 of the FSP. The soil vapor samples are grab samples and the vapor intrusion samples are time weighted average (TWA) samples. Manufacturer's specifications and recommendations for all equipment should be followed.

## **2.0 OBJECTIVES**

This standard operating procedure is intended to:

- Insure that the vapor samples collected will be representative of actual site conditions.
- Insure quality control and consistency in taking samples.
- Serve as a means to allow traceability of error(s) in sampling and data recording.

## **3.0 EQUIPMENT NEEDED**

- Field notebook and sample collection forms;
- Permanent marker;
- Teflon tubing;
- Air purging pump;
- 6L passivated Summa canister and ID tag;
- Sampling regulator (24 hr);
- Stopwatch;
- Particulate matter filter (2  $\mu$ g sintered stainless steel inline filter);
- Misc. tools; and
- Laboratory chain of custody.

## **4.0 OPERATING PROCEDURE**

### **4.1 Soil Vapor Sample Collection**

Procedures for collecting VOC samples from soil vapor are as follows:

1. Review project FSP for site-specific sampling requirements and procedures.
2. Record vapor probe number, location, date, time, and other pertinent information in field notebook and sample collection forms.
3. Use purging pump to remove one well volume from the vapor probe. Connect purging pump to wellhead using Teflon tubing. New or dedicated tubing will be used for well purging and sample collection.
4. Inspect Summa canister, valves, and fittings for damage or defects. Any sampling equipment determined to be damaged or defective will not be used.

5. Remove cap to Summa canister. Connect inline particulate matter filter to Summa canister. This apparatus is then connected to the wellhead using the Teflon tubing.
6. Open valve on the Summa canister. There should be an audible rush of air entering the canister. The canister should equilibrate within 1-2 minutes.
7. Once sampling is complete, close valve on the Summa canister. Replace cap to Summa canister. Record end time in the field notebook and on the sample collection forms.
8. Enter sample information on the canister tag and attach to the Summa canister.
9. Enter sample information on the laboratory chain of custody.

#### **4.2 Vapor Intrusion Sample Collection**

Procedures for collecting VOC samples for vapor intrusion are as follows:

1. Review project FSP for site-specific sampling requirements and procedures.
2. Record sample number, location, date, time, and other pertinent information in field notebook and sample collection forms.
3. Inspect Summa canister, valves, and fittings for damage or defects. Any sampling equipment determined to be damaged or defective will not be used.
4. Remove cap to Summa canister. Connect sampling regulator and inline particulate matter filter to Summa canister.
5. Open valve on the Summa canister. Record start time and regulator type in the field notebook and on the sample collection forms.
6. Once sampling interval is complete, close valve on the Summa canister. Replace cap to Summa canister. Record end time in the field notebook and on the sample collection forms.
7. Enter sample information on the canister tag and attach to the Summa canister.
8. Enter sample information on the laboratory chain of custody.



## Form 200-A

## Canister Sampling Collection Form

Site: \_\_\_\_\_

Project No: \_\_\_\_\_

Samplers: \_\_\_\_\_

Date: \_\_\_\_\_

\_\_\_\_\_

Sample #					
Location					
Summa ID					
Regulator Used					
Analysis/Method					
Start Time					
End Time					
Summa went to Ambient?	Yes / No	Yes / No	Yes / No	Yes / No	Yes / No
Pressure Gauge					
Pressure Gauge					
Flow Rate (pre)					
Flow Rate (post)					
Flow Rate (avg)					
Comments					

**Standard Operating Procedure**  
**For**  
**Shipping Environmental Samples**

Prepared by: \_\_\_\_\_

Date: \_\_\_\_\_

Reviewed by: \_\_\_\_\_

Date: \_\_\_\_\_

Approved by: \_\_\_\_\_

Date: \_\_\_\_\_

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## **1.0 SCOPE**

This standard operating procedure (SOP) describes the steps for shipping environmental samples for laboratory analysis. The procedures outlined in this SOP should ensure that shipping activities comply with DOT regulations (49 CFR 173 to 177) and the International Air Transportation Association (IATA).

## **2.0 OBJECTIVES**

- Ensure that collected samples are securely delivered to analytical laboratories.
- Use consistent methods that minimize the potential for shipping errors that could threaten sample integrity.
- Serve as a means to allow traceability of error(s) in sampling and data recording.

## **3.0 EQUIPMENT NEEDED**

- Cooler
- Waterproof and permanent marker;
- Ball point pen;
- Clear plastic tape;
- Strapping Tape;
- Scissors;
- Ice;
- ~~Zip~~lock storage bags;
- Large, heavy-duty plastic bag;
- Cushioning materials, (foam pellets, bubble wrap); and
- Courier airbills.

## **4.0 PROCEDURE**

Environmental samples shall be packed prior to shipment by commercial air carrier using the following procedures:

1. Select a sturdy cooler in good repair. Secure and tape the drain plug (inside and outside) with fiber or duct tape. Line the cooler with a large heavy duty plastic bag. This practice keeps the inside of the cooler clean and minimizes cleanup at the laboratory after samples are removed.
2. Be sure the lids on all bottles are tight (will not leak). In many regions custody seals are also applied to sample container lids. The reason for this practice is two-fold: to maintain integrity of samples and keep lid on the container should the lid loosen during shipment. Check with the appropriate regional procedures prior to field work. In many cases, the laboratory manager of the analytical lot to be used on a particular project can also provide this information.

3. It is good practice to wrap all glass containers in bubblewrap or other suitable packing material prior to placing in plastic bags.
4. Place all bottles in separate and appropriately sized polyethylene bags and seal the bags with tape (preferably plastic electrical tape, unless the bag is a zipper-type bag). Up to three VOA bottles, separately wrapped in bubblewrap, may be packed in one plastic bag.
5. Place bubble wrap or other cushioning material in the bottom of the cooler and then place the bottles and jars in the cooler with sufficient space to allow for the addition of more cushioning material between the bottles and jars.
6. Put ice that has been placed in properly sealed, double-bagged, heavy duty polyethylene bags on top of and between the samples. Include a temperature blank so the laboratory can ensure proper temperature upon receipt. Fill all remaining space between the bottles or jars with packing material. Fold and securely fasten the top of the large heavy-duty plastic bag with tape (preferably electrical or duct).
7. Place the Chain-of-Custody Record and the Request for Analysis Form (if applicable) into a plastic bag, tape the bag to the inner side of the cooler lid, and then close the cooler and securely tape (preferably with fiber tape) the top of the cooler unit. Wrap the tape three to four times around each side of the cooler unit. Custody seals should be affixed to the top and sides of the cooler within the securing tape so that the cooler cannot be opened without breaking the seal.
8. Each cooler (if multiple coolers) should have its own Chain-of-Custody Record reflecting the samples shipped in that cooler.
9. Label according to 40 CFR 261.4(d). The shipping containers should be marked "THIS END UP," and arrow labels which indicate the proper upward position of the container should be affixed to the container. A label containing the name and address of the shipper and laboratory shall be placed on the outside of the container. It is good practice to secure this label with clear plastic tape to prevent removal during shipment by blurring of important information should the label become wet. The commercial carrier is not required to sign the COC record as long as the custody seals remain intact and the COC record stays in the cooler. The only other documentation required is the completed airbill, which is secured to the top of the shipping container. Please note several coolers/shipping containers may be shipped under one airbill. However, each cooler must be labeled as "Cooler 1 of 3, Cooler 2 of 3, etc." prior to shipping. Additionally it is good practice to label each COC form to correspond to each cooler (i.e., 1 of 3, 2 of 3, etc.).

**Standard Operating Procedure**  
**For**  
**Decontamination of Heavy Equipment**

Prepared by: \_\_\_\_\_

Date: \_\_\_\_\_

Reviewed by: \_\_\_\_\_

Date: \_\_\_\_\_

Approved by: \_\_\_\_\_

Date: \_\_\_\_\_



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**1.0 SCOPE**

This procedure addresses drilling equipment, test pit equipment (i.e. backhoe) and monitoring well material decontamination and should be consulted during the preparation of project-specific plans. This procedure does not pertain to personnel decontamination, or to chemical sampling or field analytical equipment decontamination. The purpose of this SOP is to provide a general reference regarding the proper decontamination of drilling rigs and monitoring well materials used in the performance of field investigations.

**2.0 OBJECTIVES**

- Prevent cross-contamination between samples.
- Insure quality control in decontamination of field equipment used in sampling and handling environmental samples.
- Help to maintain a clean working environment for the safety of field personnel.
- Serve as a means to allow traceability of errors in procedures.

**3.0 DEFINITIONS**

Decontamination - Decontamination is the process of removing or neutralizing contaminants which may have accumulated on **field** equipment. This process ensures protection of personnel from penetrating substances, reduces or eliminates transfer of contaminants to clean areas, prevents mixing of incompatible substances, and minimizes the likelihood of sample cross-contamination.

**4.0 RESPONSIBILITIES**

Project Manager - It is the responsibility of the Project Manager to ensure that project-specific plans are in accordance with these procedures. Documentation should be developed for areas where project plans deviate from these procedures.

Field Manager - It is the responsibility of the Field Team Leader to ensure that these procedures are implemented in the field. The Field Team Leader is responsible for ensuring the field personnel overseeing decontamination activities, and personnel conducting the activities have been briefed and trained to execute these procedures.

Drilling Inspector (Site Geologist, Rig Geologist etc.) - It is the responsibility of the drilling inspector to ensure that the drilling/excavation subcontractor follows these, or other project-specific procedures as directed by the Field Team Leader.

**5.0 PROCEDURE**

The various drilling equipment and materials involved with test boring, test pit excavation, subsurface soil sampling, and monitoring well construction must be properly decontaminated to ensure that chemical analysis results reflect actual concentrations present at sampling locations. These procedures will minimize the potential for cross contamination between sampling locations and the transfer of contamination off site.

---

**5.1 Equipment**

All drilling equipment involved in field sampling activities shall be decontaminated prior to drilling, excavation, or sampling activities. Such equipment includes drilling rigs, backhoes, augers, downhole tools, well casings, and screens. Split-spoon soil samplers and other similar soil sampling devices shall be decontaminated according to the procedures given in SOP 190, Decontamination of Sampling Equipment.

**5.2 Decontamination Procedures**

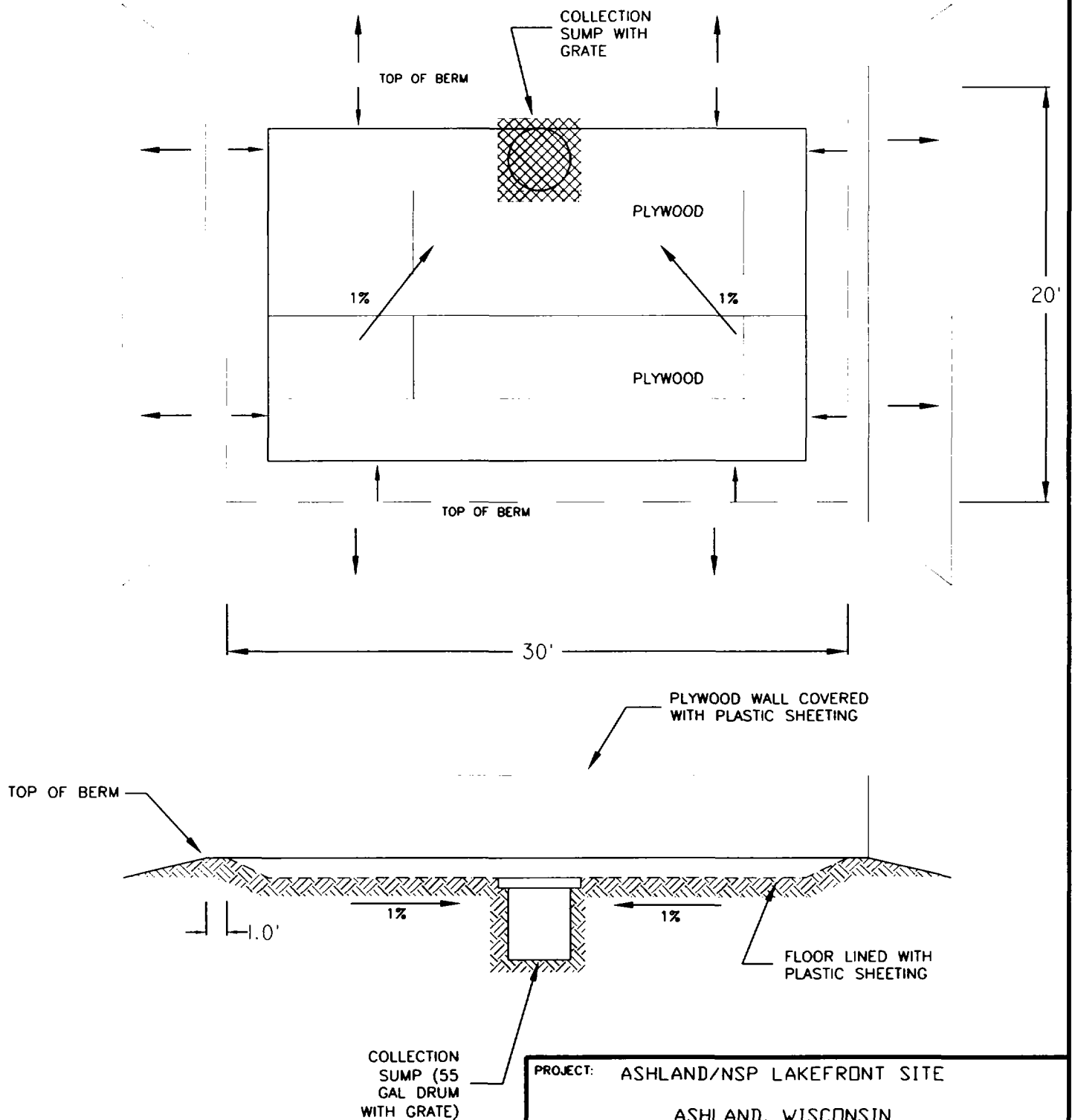
Prior to drilling, or leaving the site, large equipment not directly utilized for sampling will be decontaminated by steam cleaning on a decontamination pad in a designated area. The decontamination procedure consists of steam-cleaning the equipment, using potable water as the steam source, to remove visible signs of soils or wastes, and allowing the equipment to air dry. If necessary, the equipment may be cleaned with a scrub brush and alconox/liquinox- water solution prior to steam cleaning to remove visible signs of contamination. The use of a solvent rinse for heavy equipment decontamination is not recommended because of safety and disposal concerns.

The steam cleaning area will be designed to contain decontamination wastes and waste waters, and can be a lined, excavated pit or a bermed concrete pad or asphalt pad. For the latter, a floor- drain must be provided which is connected to a holding sump. A shallow, above-surface tank may be used or a pumping system with discharge to a waste tank may be installed. Specifications for decontamination pad construction are shown on Figure 1.

At certain sites, due to the type of contaminants or proximity to residences, concerns may exist about air emissions from steam cleaning operations. These concerns can be alleviated by utilizing one or more of the following practices:

- Locate the steam cleaning area on site to minimize potential impacts.
- Enclose steam cleaning operations. For example, augers and drilling rods can be steam cleaned in drums. Tarpaulins also can be placed around the steam cleaning area to control emissions.

Decontamination wastes will be collected and contained unless otherwise directed by the Regulatory Agency. The eventual disposition of these wastes will be determined on a project-specific basis, but may include on -site treatment and/or transport off site to an approved treatment/disposal facility.



PROJECT: ASHLAND/NSP LAKEFRONT SITE

ASHLAND, WISCONSIN

TITLE: FIGURE 1  
DECONTAMINATION PAD DETAILS

DRAWN BY: BRN

SCALE:

PROJ. NO. 25688375

CHECKED BY: AVC

DATE: 15.OCT.2004

SHEET 1 OF 1

APPROVED BY: DPT

**URS**

10200 INNOVATION DRIVE, SUITE 500  
MILWAUKEE, WISCONSIN 53226  
414.831.4100

**Standard Operating Procedure**

**For**

**Fish Tissue Sample Collection**

Prepared by: \_\_\_\_\_

Date: \_\_\_\_\_

Reviewed by: \_\_\_\_\_

Date: \_\_\_\_\_

Approved by: \_\_\_\_\_

Date: \_\_\_\_\_

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## **1.0 SCOPE**

This Standard Operating Procedure (SOP) describes the methodology for collecting fish tissues for analytical chemistry, percent moisture and percent lipid analyses. The equipment list and field procedures for these activities are described in detail.

Fish tissue sampling procedures presented here generally follow USEPA guidance (Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories,(USEPA 2000).

## **2.0 OBJECTIVES**

- Ensure that the representative fish tissue samples will be collected to properly characterize site conditions.
- Use consistent methods that reduce potential for cross contamination and avoid introducing contamination as a result of poor sampling and/or handling technique.
- Serve as a means to allow traceability of error(s) in sampling and data recording

## **3.0 EQUIPMENT NEEDED**

- Collection equipment: seine or boat-mounted electrofishing unit
- Boat equipment: personal flotation devices, nautical charts, fuel, spare parts, etc.
- Field Book/field sheets
- Global Positioning System (GPS) unit
- Buckets
- Live well
- Measuring board
- Scale
- Sample containers from laboratory
- Sample container labels
- Cooler with dry ice
- Chain-of-Custody forms
- Paper towels
- Camera and film
- Waterproof marking pens/ink pens
- Plastic bags
- Decontamination supplies
- Deionized water

## **4.0 PROCEDURE**

Three species of fish will be collected from the sediment area of concern and reference locations: smelt and two higher trophic level fish species commonly consumed by anglers and subsistence fisherman. Fish tissue

sampling will be conducted during the spawning season for smelt and during the normal fishing season for the other two species. Based upon feedback from the Trustees, the two other fish species will be selected, depending upon availability, in the following order of preference:

- Walleye
- Northern Pike
- Yellow perch
- Smallmouth bass
- Lake trout
- Round Whitefish

All collection permits should be obtained well in advance of the target sampling period to allow for flexibility in the timing of sampling. Sampling should occur after the collection of sediment quality triad samples to minimize influence of substrate disturbance that may result from fish tissue sampling (e.g., seining).

Sixteen whole fish composite samples of smelt will be collected from the sediment area of concern; sixteen whole fish composite samples of smelt will be collected at the reference locations. The number of individual smelt included in a composite sample will be based on a minimum aggregate sample of 200 grams; however, the number and size of fish in each composite will be consistent for each sampling. An effort will be made to collect larger individuals of smelt but it is more important that the size of fish in all composites are approximately the same. Sixteen individual fish of the two other higher trophic species will be collected for tissue analysis: fillets from eight individuals will be collected for the Human Health Risk Assessment (HHRA) and eight whole body samples will be collected for the Ecological Risk Assessment (ERA) from these species. A summary of fish tissue sampling is provided in Table 1:

**Table 1. Summary of fish tissue sampling.**

<b>Species</b>	<b>Sampling Location</b>	<b>Sample Type</b>	<b>Number of Samples</b>	<b>Purpose of Data</b>
Smelt	Chequamegon Bay Inlet	Composite- Whole Body	16	ERA/HHRA
	Reference	Composite- Whole Body	16	ERA/HHRA
Higher Trophic Species #1	Chequamegon Bay Inlet	Individual-Whole Body	8	ERA
		Individual-Fillet	8	HHRA
	Reference	Individual-Whole Body	8	ERA
		Individual-Fillet	8	HHRA
Higher Trophic	Chequamegon	Individual-Whole Body	8	ERA



Species #2	Bay Inlet	Individual-Fillet	8	HHRA
	Reference	Individual-Whole Body	8	ERA
		Individual-Fillet	8	HHRA

This section describes two procedures for collecting fish tissue samples for analytical chemistry, percent moisture and percent lipids. The first procedure describes the collection of smelt; the second procedure describes the collection of the other two species.

#### **4.1 Collection procedures for smelt:**

1. Select an appropriate seining location along a shallow shoreline in the sediment area of concern and reference locations using approximate sampling locations identified on Figure 4. The seining location should be accessible and free from obstructions.
2. With one sampler near shore and the seine extended perpendicular to the shoreline to another sampler, drag the seine through the water column and substrate for a length of five meters.
3. Pivot the seine around the near shore sampler in the direction the seine was dragged until the seine is parallel with the shoreline.
4. Carefully withdraw the seine from the water making sure that the bottom of the seine (lead line) remains in contact with the substrate.
5. Quickly remove captured fish from the seine and place target species (smelt) into buckets or a live well; non-target species should be returned to the water body.
6. Select a number of larger-sized smelt individuals until an aggregate weight of at least 200 grams is obtained.
7. Record the length, weight, sex (if possible), and morphological or histopathological anomalies on the field record form similar to the one provided in USEPA (2000) (Attached to SOP). Sampling conditions including water depth, time of sampling, general observations of the weather, etc. should also be noted on the field record form.
8. Vacuum-pack the composite sample and place on dry ice.
9. Complete appropriate Chain-of-Custody forms and ship overnight to laboratory for processing and analysis.

#### **4.2 Collection procedures for other species:**

1. Using boat-mounted electrofishing gear consisting of a Smith-Root GPP-5.0 electrofishing unit powered by a 240-volt generator, electrofish for 15 minutes at the approximate reference and study area locations. The discretion of the Field Team leader will determine the exact sampling location within the station area. Ideal sampling locations will target potential fish habitats including structures, snags, etc.

- 
2. Wearing insulated rubber gloves and using nets with insulated handles, collect fish stunned by the electrical field.
  3. Place fish all fish in buckets or a live well for the duration of the 15-minute sampling effort.
  4. Determine if sufficient samples of target species are present and are likely to be present at all other sampling stations, particularly reference stations.
  5. Select two target species in order of decreasing preference: walleye, lake trout, round fish, yellow perch, smallmouth bass, northern pike, and burbot.
  6. Select 16 individuals of selected species so that the smallest individual sample is no less than 0.75 times the length of the largest individual; no individual fish may weight less than 200 grams.
  7. Record the length, weight, sex (if possible), and morphological or histopathological anomalies on the field record form similar to the one provided in USEPA (2000) (Attached to SOP). Sampling conditions including water depth, time of sampling, general observations of the weather, etc. should also be noted on the field record form.
  8. Selected fish will be humanely euthanized by cervical dislocation.
  9. Fillet eight of the 16 fish of each species as described by USEPA (2000).
  10. Vacuum-pack each individual fish sample (fillets and whole body samples) and place on dry ice.
  11. Complete appropriate Chain-of-Custody forms and ship overnight to the laboratory for processing and analysis.
  12. Decontaminate fillet knife and measuring board according to SOP 190.

## **5.0 REFERENCES**

USEPA. 2000. Guidance for assessing chemical contaminant data for use in fish advisories: Volume 1 Fish sampling and analysis. Third Edition. U.S. Environmental Protection Agency. EPA 823-B-00-007.

Field Record for Fish Contaminant Monitoring Program — Screening Study					
Project Number: _____			Sampling Date and Time: _____		
<b>SITE LOCATION</b>					
Site Name/Number: _____					
County/Parish: _____			Lat./Long.: _____		
Waterbody Name/Segment Number: _____					
Waterbody Type: <input type="checkbox"/> RIVER <input type="checkbox"/> LAKE <input type="checkbox"/> ESTUARY					
Site Description: _____					
Collection Method: _____					
Collector Name: _____ <small>(print and sign)</small>					
Agency: _____			Phone: (____) _____		
Address: _____					
<b>FISH COLLECTED</b>					
Bottom Feeder—Species Name: _____					
Composite Sample #: _____			Number of Individuals: _____		
Fish #	Length (mm)	Sex	Fish #	Length (mm)	Sex
001	_____	_____	006	_____	_____
002	_____	_____	007	_____	_____
003	_____	_____	008	_____	_____
004	_____	_____	009	_____	_____
005	_____	_____	010	_____	_____
Minimum size		x 100 = _____	>75% Composite mean length _____ mm		
Maximum size					
Notes (e.g., morphological anomalies): _____					
Predator—Species Name: _____					
Composite Sample #: _____			Number of Individuals: _____		
Fish #	Length (mm)	Sex	Fish #	Length (mm)	Sex
001	_____	_____	006	_____	_____
002	_____	_____	007	_____	_____
003	_____	_____	008	_____	_____
004	_____	_____	009	_____	_____
005	_____	_____	010	_____	_____
Minimum size		x 100 = _____	≥ 75% Composite mean length _____ mm		
Maximum size					
Notes (e.g., morphological anomalies): _____					

**Figure 6-3. Example of a field record for fish contaminant monitoring program—screening study.**

**Standard Operating Procedure**

**For**

**Sediment Sampling for Toxicity Testing, Benthic Community Analysis and  
Bioavailability Analysis**

Prepared by: \_\_\_\_\_

Date: \_\_\_\_\_

Reviewed by: \_\_\_\_\_

Date: \_\_\_\_\_

Approved by: \_\_\_\_\_

Date: \_\_\_\_\_

**SEDIMENT SAMPLING FOR TOXICITY TESTING,  
BENTHIC COMMUNITY ANALYSIS AND BIOAVAILABILITY ANALYSIS****October 15, 2004**Page 2 of 6

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**SEDIMENT SAMPLING FOR TOXICITY TESTING,  
BENTHIC COMMUNITY ANALYSIS AND BIOAVAILABILITY ANALYSIS****October 15, 2004**Page 3 of 6

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**1.0 SCOPE**

This Standard Operating Procedure (SOP) describes the methodology for collecting sediment samples for toxicity testing and benthic community analysis and various analyses relating to bioavailability. The equipment list and field procedures for these activities are described in detail. In general, the procedures were developed in accordance with the Wisconsin Department of Natural Resources Field Procedures Manual Part B (WDNR 1998).

Sediment will be collected from the bioactive zone, defined as the upper four inches (10cm) of the sediment column. Stations used for collection of sediments for the toxicity testing will be matched spatially and temporally with stations used for sediment benthic macroinvertebrate community analysis. Samples used for the toxicity and bioavailability analyses (PAH forensics, soot and coal) will be taken from a composite sample composed of sediment collected from the five replicate sampling locations at each Triad and reference station. The number and locations for sampling are described in the Work Plan.

**2.0 OBJECTIVES**

- Ensure that the representative sediment samples will be collected to properly characterize site conditions.
- Ensure quality control and consistency in taking samples.
- Serve as a means to allow traceability of error(s) in sampling and data recording.

**3.0 EQUIPMENT NEEDED**

- Sampling device. This could either of the following:
  - Petite ponar grab sampler with attached line and auxillary weights
  - Ekman dredge (on a stick)
  - Coring device and liners (device should be deployable by hand, handle extensions, or gravity)
- Global Positioning System (GPS) Unit
- Field Book/field sheets
- Stainless steel spoons/bowls
- Sample containers from laboratory
- Sample container labels
- Cooler with ice
- Chain-of-Custody forms
- Paper towels
- Digital Camera/Camera with film
- Waterproof marking pens/ink pens
- Plastic bags

**SEDIMENT SAMPLING FOR TOXICITY TESTING,  
BENTHIC COMMUNITY ANALYSIS AND BIOAVAILABILITY ANALYSIS****October 15, 2004**Page 4 of 6

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- Decontamination supplies
- Deionized water
- Manual ice saw or chain saw
- Pulp tongs

**4.0 SEDIMENT SAMPLING PROCEDURES**

This section describes the procedures for collecting surface sediment samples for use in the solid phase toxicity testing, benthic macroinvertebrate community analysis and various analyses relating to bioavailability. These sampling procedures are generally consistent with 702.3 Benthic Invertebrate Surveys – Laboratory Toxicity and Bioaccumulation Sediment Tests and 701.4 General Sediment Sampling Equipment and Procedures in the WDNR Field Procedures Manual (1998). SOP 250 describes specific procedures for collecting sediment.

**4.1 Sediment Samples for Benthic Macroinvertebrate Analysis**

Sediment sampling for benthic invertebrate community analysis will be collected with a petite Ponar grab sampler or divers following the procedures described in SOP 250, except that the Ponar grab sample will be processed for benthic community analysis. If, upon collecting the sample, the grab sampler is not completely full, the sample will be discarded and another attempt will be made to obtain a full sample. For procedures to sample benthos if full samples can't be collected using a Ponar grab, see Section 4.2. Five replicate benthic samples will be collected at each Triad and reference station. Locations for replicate samples will be selected within 5 meters of station coordinates. Exact locations for replicate benthic samples will be attempted at the station's exact coordinates and at approximately 0°, 90°, 180° and 270° bearing from the station location.

Each sample will be removed from the Ponar grab and processed as follows:

1. Transfer contents of Ponar grab into a 500 micron mesh bucket sieve.
2. Rinse the sample through a 500-micron mesh sieve to remove excess sediment and detritus and place into an appropriately labeled sample jar.
3. Preserve sample using a 70% ethanol solution with Bengal Red to improve macroinvertebrate recovery from samples.
4. Label the lid of the sample container and place a waterproof sample label inside the sample container.

**SEDIMENT SAMPLING FOR TOXICITY TESTING,  
BENTHIC COMMUNITY ANALYSIS AND BIOAVAILABILITY ANALYSIS****October 15, 2004**

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5. Package samples as described in SOP 210 to prevent breakage and transport samples to URS-Fort Washington, PA office or other qualified subcontractor for processing and taxonomic analysis.
6. In the field notebook note the type of sampler, depth and time of sampling, and general observations of weather, turbidity, water depth, depth of the reduction-oxidation potential discontinuity (RPD) layer and type of substrate.

**4.2 Alternative Sampling Procedures for Sampling the Benthos**

If a Ponar grab is unable to collect a full sample the following procedures will be attempted.

- 1) Weighting the standard ponar: Additional weight can be added to the Ponar to give it additional force when it impacts the sediments. If it becomes heavier than can be retrieved by hand then a davit can be used on a boat or a tripod can be used on ice to handle more weight.
- 2) Ekman dredge: We could use the Ekman "a stick" with multiple attachments to sample in up to 10 feet of water. With the Ekman on a stick, we might be able to work the sampler into the sediments and maybe get a better grab sample. However, as with all grab samplers, if debris is caught in the doors the sample will potentially be lost as you pull it up.
- 3) Core: 9.5 cm (ID) lexan tubing. These cores have a surface area of approximately  $70.8 \text{ cm}^2$  so three cores for each proposed Ponar replicate that would be  $212.5 \text{ (cm}^2\text{)}$ , which is approaching the surface area you would get with a Petite ponar or Ekman dredge ( $\sim 22 \text{ cm}^2$ ).
- 4) A heavier box core.

During the reconnaissance study, these alternative methods (in the order listed above) will be attempted so that when the actual benthic sampling is performed a contingency method will be available.

**4.3 Sediment Samples for Sediment Toxicity Testing and Bioavailability Analysis**

- 1) At each Triad and reference station multiple grabs of surface sediment at each replicate location (See Section 4.1) will be collected and composited in a large stainless steel bowl until a volume of approximately three and  $\frac{1}{2}$  gallons is reached.
- 2) This composite sample will then be thoroughly homogenized and transferred into three separate one gallon (these are for the three bioassay tests) and approximately one half gallon (for the bioavailability analysis) decontaminated containers using a decontaminated stainless steel spoon.
- 3) All containers will be filled completely to the top so that no air space is left.
- 4) Replace lids and place in cooler as soon as possible.
- 5) Record GPS location.
- 6) Fill out chain-of-custody forms.
- 7) As soon as possible after completing sampling, place samples on ice and prepare cooler for shipping according to laboratory's instructions.



**SEDIMENT SAMPLING FOR TOXICITY TESTING,  
BENTHIC COMMUNITY ANALYSIS AND BIOAVAILABILITY ANALYSIS****October 15, 2004****Page 6 of 6**

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- 8) Decontaminate Ponar grab and stainless steel bowl and spoon according to SOP 190.

**5.0 REFERENCES**

Wisconsin Department of Natural Resources (WDNR). 1998. WDNR Field Procedures Manual. Intranet  
Edition: <http://www.dnr.state.wi.us/org/water/wm/wqs/sediment/sampling/>.

**Standard Operating Procedure**  
**For**  
**Sediment Sampling for Chemical and Physical Parameter Testing**

Prepared by: \_\_\_\_\_

Date: \_\_\_\_\_

Reviewed by: \_\_\_\_\_

Date: \_\_\_\_\_

Approved by: \_\_\_\_\_

Date: \_\_\_\_\_



**SEDIMENT SAMPLING FOR CHEMICAL AND  
PHYSICAL PARAMETER TESTING**

**October 15, 2004**

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**1.0 SCOPE**

This Standard Operating Procedure (SOP) describes the methodology for collecting bulk sediment samples for chemical analysis. The equipment list and field procedures for these activities are described in detail. The procedures are generally consistent with the Wisconsin Department of Natural Resources Field Procedures Manual Part B (WDNR 1998).

Sediment will be collected from the bioactive zone, defined as the upper four inches (10cm) of the sediment column. Sediment samples will be analyzed for the parameters listed in the Field Sampling Plan. Candidate and final sampling locations for bulk sediment chemistry are the Sediment Quality Triad sampling stations discussed in the work plan.

**2.0 OBJECTIVES**

- Ensure that the representative sediment samples will be collected to properly characterize site conditions.
- Ensure quality control and consistency in taking samples.
- Serve as a means to allow traceability of error(s) in sampling and data recording.

**3.0 EQUIPMENT NEEDED**

- Sampling device. This could either of the following:
  - Ponar grab sampler with attached line
  - Coring device and liners (device should be deployable by hand, handle extensions, or gravity)
- Global Positioning System (GPS) Unit;
- Appropriate PPE as specified in the HSP;
- Field Book/field sheets;
- Stainless steel spoons/bowls;
- Sample containers from laboratory;
- Sample container labels;
- Cooler with ice;
- Chain-of-custody forms;
- Paper towels;
- Camera and film;
- Waterproof marking pens/ink pens;
- Plastic bags;
- Decontamination supplies;
- Deionized water;
- Manual ice saw or chain saw;

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- Pulp tongs; and
- Ice chisel or ice auger.

**4.0 PROCEDURES**

This section describes the procedures for collecting bulk surface sediment samples for analysis of sediment chemistry. These sampling procedures are generally consistent with 701.4 – General Sediment Sampling Equipment and Procedures in the WDNR Field Procedures Manual (1998). The samples will be collected from an anchored boat or through ice cover using a Ponar grab sampler or coring device. Depending upon the nature of the sediment surface, i.e. presence of wood fragments, it may be necessary to employ a diver or underwater video for reconnaissance prior to collecting samples with a Ponar grab or for a diver to collect the actual sample using a diver-operated coring device.

**4.1 Procedure for Sampling from an Anchored Boat Using a Ponar Grab Sampler**

1. Approach the sampling area from a downstream to upstream direction taking care not to disturb the sediment at the sampling location.
2. Attach a sturdy nylon rope or steel cable to the ring provided on top of the Ponar Grab.
3. Arrange the Ponar grab with the jaws in the open position, setting the trip bar so the sampler remains open when lifted from the top. If the dredge is so equipped, place the spring-loaded pin into the aligned holes in the trip bar.
4. Wearing a clear pair or latex or nitrile gloves, slowly lower the decontaminated Ponar grab sampler through the water column to the top of the sediment slowly lower the sampler to a point approximately two inches above the sediment.
5. Drop the sampler to the sediment. Slack on the line will release the trip bar or spring loaded pin; pull up sharply on the line closing the dredge.
6. Raise the grab to the surface and slowly decant any free liquid through the screens on top of the dredge. Care should be taken to retain the fine sediment fraction during this operation.
7. Open the grab and transfer the sediment to a decontaminated stainless steel, plastic or other appropriate composition (e.g., Teflon) container (See Section 4.1). Ensure that non-dedicated containers have been adequately decontaminated. If necessary, continue to collect additional sediment until sufficient material has been secured to fulfill analytical requirements. Thoroughly homogenize and then transfer sediment to sample containers appropriate for the analyses requested. Samples for volatile organic analysis must be collected directly from the bucket before homogenization to minimize volatilization of contaminants.
8. In the field notebook note the type of substrate (including the presence of wood waste), the presence and depth of the reduction- oxidation potential discontinuity (RPD) layer, type of sampler, approximate percent recovery, water depth, turbidity, time of sampling, and general observations of weather.
9. Repeat the steps for lowering and retrieving the Ponar grab (if necessary) to obtain sufficient quantity of sediment for analysis of all parameters.
10. Label laboratory sample containers.
11. Fill containers for VOCs in accordance with SOP 160.

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12. Homogenize the sediment in the stainless steel bowl using a decontaminated stainless steel spoon.
13. Fill other laboratory containers with homogenized sediment.
14. Replace lids and place in cooler as soon as possible.
15. Record GPS location.
16. Fill out chain-of-custody forms.
17. As soon as possible after completing sampling, place samples on ice and prepare cooler for shipping according to laboratory's instructions.
18. Decontaminate Ponar grab and stainless steel bowl and spoon according to SOP 190.

**4.2 Procedure for Sampling from an Anchored Boat Using a Coring Device**

Sediment cores will be collected using a hand core sampler (e.g., Wildco Hand Core Sampler) that can be deployed by gravity on a line, by handle extensions up to 15 feet long, or by a diver. The method of deployment will depend on water depths at each sampling station. In water depths less than 15 feet, extension handles will be attached to the core head and the corer will be pushed into the sediment. In water depths greater than 15 feet, a line will be attached to a clevis on the head assembly and the corer will be dropped to the bottom, penetrating the sediments by gravity. If the nature of the sediment surface requires a diver to collect the sample, the corer will be pushed into the sediment by hand.

1. Approach the sampling area from a downstream to upstream direction taking care not to disturb the sediment at the sampling location.
2. Wearing a clear pair or latex or nitrile gloves, insert a cellulose acetate butyrate (CAB) or stainless steel core liner into the corer.
3. Insert an "eggshell" catcher into the lower end of the tube with the convex surface positioned inside the acetate core.
4. Screw the nosecone onto the lower end of the corer, securing the core liner and the "eggshell" catcher.
5. Depending on water depth and sediment conditions, deploy the corer as follows:
  - Penetrable sediments in less than 15 feet of water: Push the corer into the sediments using handle extensions;
  - Penetrable sediments in greater than 15 feet of water: With a line attached, drop the corer from the surface, allowing the corer to penetrate the sediments by gravity;
  - Semi-penetrable sediments: Deploy a diver and push the corer into the sediments by hand.
- Once the corer has penetrated to the desired depth of sediment, rotate the sampler to shear off the core at the bottom.
- Slowly retrieve the corer from the sediments, carefully removing it from the water when it reaches the surface.
- Unscrew the nosecone of the corer and remove the "eggshell" catcher.
- Slide the core liner out of the corer, placing a cap on the bottom of the liner as it is removed. Decant surface water from the top of the liner, using care to retain fine-grain sediments.
- In the field notebook note the type of substrate (including the presence of wood waste), the presence and depth of the reduction-oxidation potential discontinuity (RPD) layer, type of sampler,

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approximate percent recovery, water depth, turbidity, time of sampling, and general observations of weather.

- If the sample is to be homogenized, transfer the sample to a decontaminated container (e.g., stainless steel bowl). If necessary, continue to collect additional sediment until sufficient material has been secured to fulfill analytical requirements. Thoroughly homogenize using a decontaminated stainless steel spoon and then transfer sediment to sample containers appropriate for the analyses requested. (Note: Samples for volatile organic analysis must be collected directly from the bucket before homogenization to minimize volatilization of contaminants.) Label laboratory sample containers and fill with homogenized sediment. Replace lids and place in cooler as soon as possible.
- If the core is to be delivered intact, cut the liner near the sediment surface using a pipe cutter or hacksaw to minimize headspace in the core. Cap the top of the liner and indicate the appropriate orientation of the sediment core using indelible ink. As soon as possible, place the intact core in cooler with the top of the core oriented up.
- Record GPS location.
- Fill out chain-of-custody forms.
- As soon as possible after completing sampling, place samples on ice and prepare cooler for shipping according to laboratory's instructions.
- Decontaminate corer, core liner (if non-dedicated), stainless steel bowl, and spoon according to SOP 190.

**4.3 Procedure for Sampling through Ice Cover**

This section provides detailed procedures for sampling through ice cover if sediment sampling occurs while the lake is frozen. The optimal time for sampling through the ice cover is after the lake has frozen to a thickness sufficient to safely support the weight of the sampling crew and equipment, but before the ice becomes too thick to cut through or handle. Optimal ice thickness for sampling ranges from six to 18 inches, depending on conditions. Procedures for sampling through ice cover are described in detail below; safety procedures are excerpted from "Safety on Floating Ice Sheets" (USACE 2004):

1. Never go out on an ice cover alone, and never go out on the ice if there is any question of its safety.
2. Estimate the total load of the sampling crew and equipment, then determine the minimum ice thickness required to support the load using the following equation:

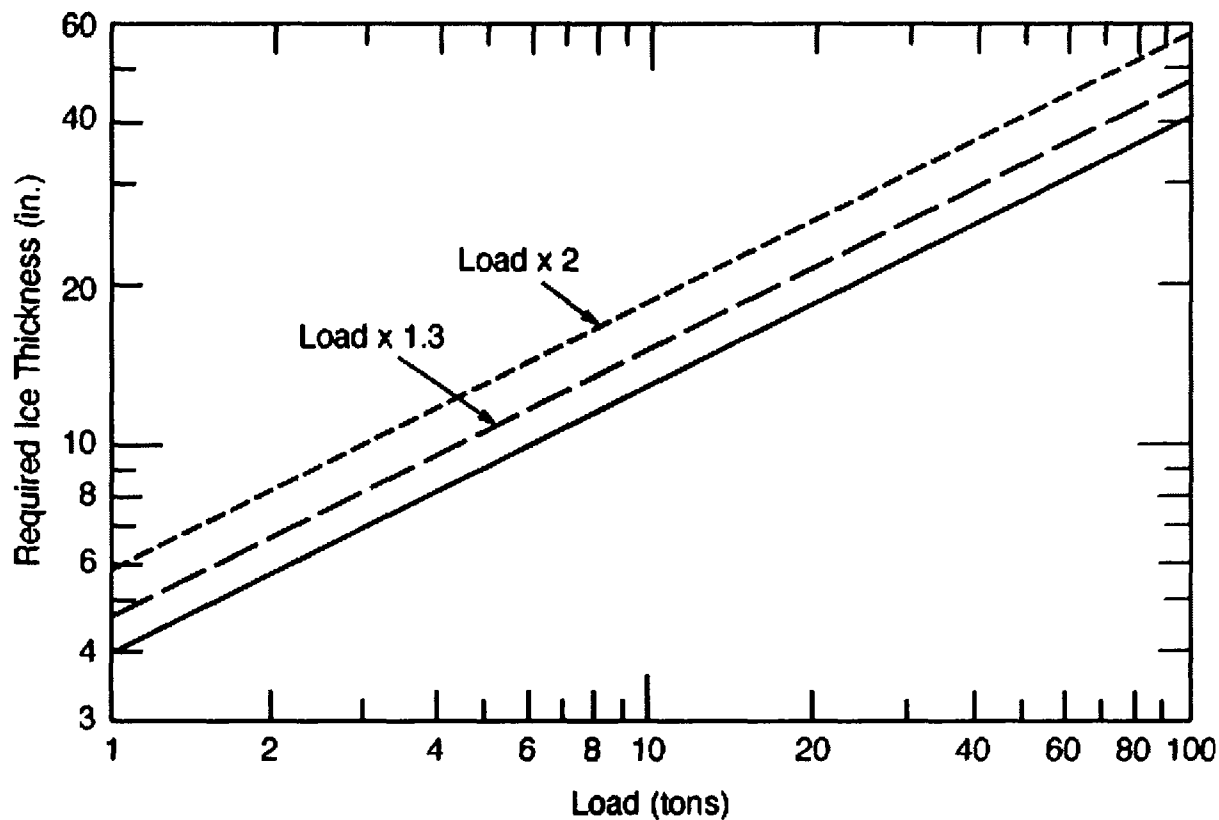
$$h = 4\sqrt{P}$$

where  $h$  is the ice thickness in inches and  $P$  is the load, or gross weight, in tons. You can also use the graph or table to determine the minimum thickness:

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Load (tons)	Required ice thickness (inches)	Distance between loads (feet)
0.1	2	17
1	4	34
2	6	48
3	7	58
4	8	67
5	9	75
10	13	106
20	18	149
30	22	183
40	26	211

The equation, graph, and table are valid when the load (such as a person on foot, or a wheeled or tracked vehicle) is distributed over a reasonable area of a continuous ice sheet. The larger the load, the greater the area it should cover for the calculation to remain valid. Neither large loads that are concentrated in relatively smaller areas, nor loads that are at or near the edge of a large opening in the ice, are safely described by the equation, graph, or table. In such cases, seek more advice.

The equation, graph and table assume clear, sound ice. If white, bubble-filled ice makes up part or all of the ice thickness, count it as only half as much clear ice.

Any recent large snowstorm creates a new load on the ice. If the new snow is heavy enough, the ice sheet will sag and its top surface will be submerged below the water level. Then water will flood the top of the ice sheet through cracks, saturating the lower layers of the snow. Until this slush is completely frozen, stay off the ice sheet. When the saturated snow becomes frozen, it is an added thickness of white ice.

You are likely to encounter cracks in the ice. Cracks are either wet or dry. If they are dry, they do not penetrate the ice sheet and are not a concern. If they are wet, multiply the load by 2, as shown on the graph, before you use the equation to obtain the required minimum ice thickness.

If you plan to leave a load on the ice for extended periods, usually more than two hours, multiply the load by 2 (as shown by the upper dashed line in the graph) before you use the equation to find the required minimum ice thickness.

3. While you are planning the outing, obtain the record of air temperature for the past several days and continue observing air temperatures while the ice will be used to support loads. Contrary to what you would expect, a rapid, large air temperature drop makes an ice sheet brittle, and the ice may not be safe to use for 24 hours or more. If the air temperature has been above freezing for at least 6 of the past 24 hours, multiply the load by 1.3 before you use the equation (or use the lower dashed line on the graph), obtaining a larger minimum ice thickness to account for any possible weakening. If the air temperature stays above freezing for 24 hours or more, the ice starts losing strength, and the equation, figure, and table no longer represent safe conditions. Stay off the ice!

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4. When you arrive at the water's edge, visually survey the ice. Look for open water areas, and look for signs of recent changes in water levels: ice sloping down from the bank because the water dropped, or wet areas on the ice because the water rose and flooded areas of the ice that couldn't float because it was frozen to the bottom or the banks. (If the ice is snow-covered, look for wet areas in the snow.)
5. Listen for loud cracks or booms coming from the ice. In a river this can mean the ice is about to break up or move; on a lake larger than several acres such noises may be harmless responses to thermal expansion and contraction.
6. Look for an easy point of access to the ice, free of cracks or piled, broken ice.
7. Determine the thickness of the ice by drilling holes with the drill or ice auger. The technique is to drill a hole and check the ice thickness every 150 feet or so along the intended path. This should be done more frequently if the ice thickness is quite variable. Near shore, listen for hollow sounds while probing. Ice sloping down from the bank may have air space underneath. This is not safe; ice must be floating on the water to support loads. Note whether the ice in each hole is clear (sometimes called black ice) or white (due to air bubbles—sometimes called snow ice). Measure the thickness of both kinds.

On rivers the ice thickness and quality can change a lot in a short distance; be particularly alert to variations in ice thickness due to bends, riffles or shallows, junctions with tributaries, etc. For both rivers and lakes, warm inflows from springs can create areas of thinner ice. The ice near shores can either be thinner (due to warm groundwater inflow or the insulating effect of drifted snow) or thicker (due to the candle-dipping effect of variable water levels).
8. Measure the snow cover thickness on the ice cover; significant variations in thickness may mean highly variable ice thickness.
9. If you are taking a vehicle or other equipment on the ice, go out on foot first. Vigorously probe ahead of yourself with the ice chisel. If the chisel ever goes through, carefully turn around and retrace your steps back to shore, and try again some other day. Only after you have learned the characteristics of the ice cover should any vehicle be taken on the ice.
10. After getting on the ice, others in the group should follow in the leader's steps, but stay at least 10 feet apart.
11. Navigate to the pre-determined sampling station using a hand-held Global Positioning System (GPS) unit.
12. Using a manual ice saw or a chainsaw, make an approximately 3' x 3' cut in the ice. Once the outer cut is made, quarter the 3' x 3' block of ice into manageable blocks. (Note: To avoid potential PAH contamination of sampling equipment, substitute cooking oil for petroleum-based bar oil in the chainsaw. If possible, use a brand new chainsaw to eliminate the possibility of contamination from residual petroleum-based bar oil.)
13. Remove the ice blocks using pulp hooks.
14. Using the desired sampling device (See Sections 4.1 and 4.2 for sample collection procedures for Ponar grab samplers and coring devices), collect a sample from each of the four corners of the opening in the ice. Collecting more than 4 samples from each opening in the ice may result in the collection of sediments disturbed by previous sampler deployments.
15. Process the samples according to Section 5.0.

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16. Repeat the procedure until a sufficient number of openings have been made to collect the prescribed number of samples for that station.
  17. Once all samples have been collected from the station, use the blocks to cover the opening in the ice. (Note: Do not place the blocks in the opening so that they are flush with the ice. The blocks should be situated irregularly in the opening to clearly indicate an anomaly in the ice surface.)

**5.0 REFERENCES**

- USACE. 2004. Safety on Floating Ice Sheets. U.S. Army Cold Regions Research and Engineering Lab. Hanover, NH. Available at: [http://www.crrel.usace.army.mil/ierd/ice\\_safety/safety.html](http://www.crrel.usace.army.mil/ierd/ice_safety/safety.html). Updated August 2004.
- Wisconsin Department of Natural Resources (WDNR). 1998. WDNR Field Procedures Manual. Intranet Edition. <http://www.dnr.state.wi.us/org/water/wm/wqs/sediment/sampling/>.

**Standard Operating Procedure**

**For**

**Field Screening Procedures**

Prepared by: \_\_\_\_\_

Date: \_\_\_\_\_

Reviewed by: \_\_\_\_\_

Date: \_\_\_\_\_

Approved by: \_\_\_\_\_

Date: \_\_\_\_\_

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## **1.0 SCOPE**

This Standard Operating Procedure (SOP) describes the methodology for screening soil samples. Field screening is conducted by headspace analysis of soil samples using a photoionization detector (PID). Field screening allows field personnel to qualitatively measure the levels of soil contamination in the field. See SOP 140 for procedures for soil sample collection.

## **2.0 OBJECTIVES**

- Ensure quality control in field screening measurement.
- Ensure uniformity and continuity in measuring techniques by different qualified field personnel.
- Provide semi-quantitative data for use in determining relative variations in contamination between two or more soil samples.

## **3.0 EQUIPMENT NEEDED**

- Field notebook;
- Plastic ~~Zip~~-Loc style bags;
- Photoionization detector (PID);
- 100 ppm Isobutylene gas standard; and
- Waterproof marking pens/ink pens.

## **4.0 PID CALIBRATION**

Maintenance of the PID is conducted in the factory and internal controls will not be reset in the field. Daily calibration should be accomplished by initiating the menu driven calibration procedures while the PID is running. ~~Zeo~~ air gas will be used to zero the instrument. A 100 ppm Isobutylene standard will be used to calibrate the instrument's span setting. If the instrument presents a message stating that it has failed to properly calibrate, follow the instructions in the user's manual. Calibration should be conducted prior to each workday and after restarting the instrument if the power is shut off. A check for drift in calibration should be conducted at the end of each day by reading and recording the concentration of the same standard used for calibration.

## **5.0 PROCEDURES**

Soil samples to be field screened should be handled using the following procedures. The screened samples will be tested using a calibrated PID with a lamp energy of 10.6 eV unless otherwise directed by the Project Manager. The operator of the PID should be thoroughly familiar with the operation of the instrument. New plastic bags will be used to contain headspace analysis. A representative bag should be tested for background levels using ambient air at the temperature and volume to be used during screening.

1. Collect the headspace sample directly from the sampler into a new plastic bag. Headspace samples should have the same ratio of sample to air each time. Excess air can be bled off while sealing the bag. The analytical sample should be collected from the sampler at the time the headspace sample is collected.

2. Agitate the soil in the bag. Make sure that the bag is not punctured in the process.
3. Set the bag out of direct sunlight in a warm place to allow vapors to equilibrate. If the temperature is below 40 degrees Fahrenheit, the sample should be heated. The time required for equilibration should be based on the temperature at sampling as follows:

<u>Temperature</u>	<u>Equilibration time</u>
70	5 minutes
69-56	10 minutes
55-41	20 minutes
40	40 minutes

4. Once equilibrated, slightly open the bag and insert the PID probe. Measure the VOC concentrations for 60 seconds and record the maximum reading in the field notebook and boring logs. Describe any trends such as slow concentration rises or sudden drops. If the readings drop to a stable level record that value. There should be sufficient air in the bag so that the bag contains enough air throughout the 60 second sampling period. Readings taken when the bag is collapsed and a vacuum is developing are not acceptable.

## **6.0 ORGANIC VAPOR ANALYZER SELECTION**

The selection of the appropriate organic vapor analyzer equipped with either a PID or flame ionization detector (FID) shall be based on contaminants of concern and/or ambient conditions at the respective site. The lamp selected for the PID, where applicable, will be based on the relative ionization potentials of the expected volatile contaminants. The selected instrument and rationale for use will be recorded in the field notebook.

**Standard Operating Procedure**  
**For**  
**Non Aqueous Phase Liquid Measurement**

Prepared by: \_\_\_\_\_

Date: \_\_\_\_\_

Reviewed by: \_\_\_\_\_

Date: \_\_\_\_\_

Approved by: \_\_\_\_\_

Date: \_\_\_\_\_



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## **1.0 SCOPE**

This Standard Operating Procedure (SOP) describes the methodology for measuring non aqueous phase liquid (NAPL) in monitoring wells and piezometers. Measurement of NAPLs is a useful tool for evaluating contaminant source areas and monitoring trends in contaminant behavior.

## **2.0 OBJECTIVES**

- Ensure quality control in NAPL measurement.
- Ensure uniformity and continuity in measuring techniques by different qualified field personnel.
- Allow traceability of errors in NAPL measurement, and correction of improper procedures.

## **3.0 EQUIPMENT NEEDED**

- Field notebook;
- Waterproof marking pens/ink pens;
- Plastic sheeting (Visqueen);
- Appropriate safety equipment;
- Interface probe;
- Nylon rope and weight;
- Knife or scissors;
- Tape measure;
- Disposable bailer;
- Decontamination equipment;
- Waterproof marking pens/ink pens.

## **4.0 PROCEDURES**

Procedures required will depend on whether light NAPL (LNAPL) that forms lenses floating on top of the water table or dense NAPL (DNAPL) that sinks through the aquifer and forms lenses over lower permeability layers are present.

### **4.1 Interface Probe Measurements**

The interface probe, which consists of a fluid detector attached to a graduated tape, is used for depth measurements in monitoring wells and piezometers. The probe has the capability of evaluating fluid in the monitoring wells for LNAPLs and DNAPLs. Manufacturer's recommendations for operation should always be followed. The following describes the operation of the interface probe:

1. Place the interface probe in the monitoring well/piezometer adjacent to the measuring mark on the top of the well casing.

2. Slowly lower the probe down the well until it intersects the top of the fluid layer. If LNAPLs are encountered the probe will "sound" a continuous tone. If water is encountered, the probe will "sound" an intermittent tone.
3. Record the depth to the top of the fluid in the field logbook. The probe has an accuracy of 0.01 foot.
4. Continue lowering the probe and record the depth of any change in tone (continuous or intermittent). If a solid tone is noted below the groundwater level, a DNAPL is present in the well.
5. Continue lowering the probe to the base of the well and record the total depth in the field logbook.
6. Properly decontaminate the probe. See SOP 190 for decontamination procedures.

#### **4.2 Alternate Measurement Methods**

Occasionally, certain types of NAPLs can be difficult to accurately measure using an interface probe. One alternative is to use a clear, disposable bailer to extract a portion of the water column in the well. This can be the bailer dedicated to the well for sampling. For LNAPLs, the bailer is slowly lowered so the top of the bailer does not fall below the top of the fluid layer and then removed from the well for measurement. For DNAPLs, the bailer is slowly lowered to the bottom of the well and then removed from the well for measurement. The NAPL thickness can be directly measured from the bailer using a tape measure. This method is not as accurate as using an interface probe, but can produce consistent results.

Another method for measuring DNAPLs is to use a clean nylon rope with a weight. The decontaminated weight is secured to the nylon rope and slowly lowered to the bottom of the well. On reaching the bottom of the well, the weight and rope are removed and placed on plastic sheeting for measurement with a tape measure. This method is not as accurate as using an interface probe, but can produce consistent results.

**Standard Operating Procedure**  
**For**  
**Placement and Servicing of ADCP and Pressure Transducer**

Prepared by: \_\_\_\_\_

Date: \_\_\_\_\_

Reviewed by: \_\_\_\_\_

Date: \_\_\_\_\_

Approved by: \_\_\_\_\_

Date: \_\_\_\_\_



**PLACEMENT AND SERVICING OF ADCP AND  
PRESSURE TRANSDUCER**

**October 15, 2004**

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PRESSURE TRANSDUCER****October 15, 2004**Page 3 of 4

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**1.0 SCOPE**

This Standard Operating Procedure (SOP) describes the methodology for deploying, servicing, and processing data from a downward-looking Acoustic Doppler Current Profiler (ADCP) and pressure transducer for the purpose of obtaining detailed vertical profiles of wave and currents speeds and wave heights as well as profiles of suspended sediment. Data from these devices will be used to develop vertical profiles of the velocities and suspended sediments in the wave/current boundary layer in the affected area of the site.

**2.0 EQUIPMENT NEEDED**

- Tripod-mounted ADCP
- Fully equipped workboat
- Surface buoy
- Global Positioning System (GPS) unit
- Field notebook
- Camera and film

**3.0 PROCEDURES**

The following sections identify procedures for deploying, servicing, and processing data from a downward-looking ADCP and pressure transducer:

**3.1 Deployment and Servicing**

A tripod-mounted ADCP and pressure transducer will be deployed for one month in a position that is centrally located in the affected area. Deployment procedures are as follows:

1. Verify the factory calibration of the ADCP according to the manufacturer's specifications prior to installation. Document the performance of the instrument during calibration in a field notebook.
2. Prepare the tripod-mounted ADCP for deployment according to the manufacturer's specifications. The system will be configured to record signals at 10 Hz or higher for two-minute bursts every two hours for the one-month deployment.
3. Approach the pre-determined location for deployment in a small, fully equipped workboat.
4. At the selected location, lower the tripod-mounted ADCP to the bottom and anchor according to the manufacturer's specifications.
5. Mark the location of deployment with a surface buoy and an integral underwater transponder.
6. Record the location of the ADCP with a GPS unit.

Two weeks following deployment, check the ADCP to verify that it is operating properly. At this time, make necessary modifications to the ADCP and appropriately adjust the duration of the deployment.

**3.2 Processing**

After the one-month deployment, the ADCP will be retrieved and the data will be downloaded from the unit according to the manufacturer's specifications. The data will be reviewed to determine whether a sufficient

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PRESSURE TRANSDUCER****October 15, 2004**

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range of wave and current conditions have been captured during the deployment. If a sufficient range of data has not been collected, the ADCP will be redeployed until a sufficient dataset has been obtained.

Post processing of an adequate dataset will provide:

- A wave and current dataset for calibrating wave-wave and wind-wave transformation models;
- Suspended sediment time series data for verifying the wave/current boundary layer model; and
- Estimates of bottom roughness and its variation with hydrodynamic forcing.

**Standard Operating Procedure**  
**For**  
**Collection of Core Samples for Sediment Stability Studies**

Prepared by: \_\_\_\_\_

Date: \_\_\_\_\_

Reviewed by: \_\_\_\_\_

Date: \_\_\_\_\_

Approved by: \_\_\_\_\_

Date: \_\_\_\_\_



**COLLECTION OF CORE SAMPLES FOR  
 SEDIMENT STABILITY STUDIES**

**October 15, 2004**

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SEDIMENT STABILITY STUDIES****October 15, 2004**Page 3 of 7

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**1.0 SCOPE**

This Standard Operating Procedure (SOP) describes the methodology for collecting sediment cores for sediment stability studies. The equipment list and field procedures for these activities are described in detail.

Sediment cores will be collected from sampling stations determined during the reconnaissance study described in Section 4.3.3.4 of the Work plan. Approximately five one-foot sediment cores will be collected for use in erosion testing; six offshore two-foot cores will be collected for use in age dating, grain-size and chemical analyses. At each location, multiple cores may be required to support age dating, grain-size and chemical analysis. Field sampling procedures for collecting cores for sediment stability analyses are described in the sections below.

**2.0 OBJECTIVES**

- Insure that the representative sediment samples will be collected to properly characterize site conditions.
- Insure quality control and consistency in taking samples.
- Serve as a means to allow traceability of error(s) in sampling and data recording.

**3.0 EQUIPMENT NEEDED**

- Coring device;
- Duct tape;
- Global Positioning System (GPS) Unit;
- Tape measure;
- Field notebook/field sheets;
- Stainless steel spoons/trowels/spatulas/bowls;
- Sample containers from laboratory;
- Sample container labels;
- Plunger or equivalent device with diameter equal to inner diameter of coring device;
- Cooler with ice;
- Chain-of-custody forms;
- Paper towels;
- Camera and film;
- Waterproof marking pens/ink pens;
- Plastic bags;
- Appropriate personal protective equipment;
- Decontamination supplies; and
- Plastic sheeting.

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SEDIMENT STABILITY STUDIES****October 15, 2004**

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**4.0 PROCEDURES**

The method used to collect sediment cores for sediment stability studies will be dependent upon the nature of the sediment. If the sediment is not compact and free of debris, sediment cores will be collected by manually advancing push cores into the sediment. If push cores cannot be manually advanced into the sediment, a vibracoring device will be used to collect the cores. The procedures for both methods of collection are described below:

**4.1 Collection of Push Cores**

If the sediment is suitable, push cores will be used to collect sediment for age-dating analyses and erosion testing. Cores for age-dating, grain-size, and chemical analyses need to be approximately two feet in length; therefore a two-foot hand core sampler should be a suitable coring device. One-foot cores required for erosion testing will be collected using a coring device with inner and outer diameters consistent with the specifications of Sedflume provided by the designated erosion testing laboratory (See SOP 350).

**Age-dating Analyses**

In penetrable sediments, two-foot sediment cores for age-dating, grain-size, and chemical analyses will be collected using an appropriate push coring device (e.g., Wildco Hand Core Sampler) that can be deployed by handle extensions up to 15 feet long. At each location, multiple cores may be required to support age dating, grain-size and chemical analyses. Consult the SOP 340 to determine how much sediment volume is required to conduct radiometric, grain size and chemical analysis.

1. Approach the sampling area from a downstream to upstream direction taking care not to disturb the sediment at the sampling location.
2. Wearing a clear pair or latex or nitrile gloves, insert a cellulose acetate butyrate (CAB) liner into the corer.
3. Insert an "eggshell" catcher into the lower end of the tube with the convex surface positioned inside the acetate core liner.
4. Screw the nose cone onto the lower end of the corer, securing the core liner and the "eggshell" catcher.
5. In penetrable sediments in less than 15 feet of water, push the corer into the sediments to the desired depth using handle extensions;
6. Once the corer has penetrated to the desired depth of sediment, rotate the sampler to shear off the core at the bottom.
7. Slowly retrieve the corer from the sediments, carefully removing it from the water when it reaches the surface.
8. The coring sleeve is then brought back up and lifted onto the boat deck, the nose cone is removed, and the barrel lifted off the core tube.
9. Cores will immediately be visually inspected for length and quality. Cohesive sediments that show signs of disturbance during the coring process will be discarded and another core will be taken from that site.

**COLLECTION OF CORE SAMPLES FOR  
SEDIMENT STABILITY STUDIES****October 15, 2004**

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10. After collection, the cores should be transported to an onshore site for sub-sampling, packing and shipping according to Section 5.0 of this SOP.
11. In the field notebook note the type of substrate (including the presence of wood waste), the presence and depth of the reduction- oxidation potential discontinuity (RPD) layer, type of sampler, approximate percent recovery, water depth, turbidity, time of sampling, and general observations of weather.
12. Record GPS location.
13. Fill out chain-of-custody forms.
14. Decontaminate corer, core liner (if non-dedicated), stainless steel bowl, and spoon according to SOP 190.

**Erosion Testing**

If the sediment is suitable, push cores will used to collect sediment for erosion testing. Cores for erosion testing only need to be approximately 1 foot in length. An appropriate coring device will be selected to collect cores with inner and outer diameters consistent with the specifications of Sedflume provided by the designated erosion testing laboratory (SOP 350). All cores will be collected in clear sampling tubes to allow rapid visual assessment of core conditions and recovery.

1. Approach the sampling area from a downstream to upstream direction taking care not to disturb the sediment at the sampling location.
2. Wearing a clear pair of latex or nitrile gloves, lower the appropriately sized coring device to the bottom.
3. Using pressure and/or force (e.g., sledge hammer blows), advance the tube approximately two feet into the sediment.
4. Create a vacuum in the tube using a cap, flutter valve, or piston valve appropriate to the selected coring device.
5. Extract the core from the sediments and slowly bring the core to the surface.
6. If a nose cone and liner are used, remove the nose cone and lift the barrel from the core liner, placing caps on both ends of the liner.
7. If a nose cone and liner are not used, quickly place a cap on the bottom of the tube as the core is removed from the water.
8. Take care to maintain the core in an upright position.
9. If necessary, cut the tube near the sediment surface using a pipe cutter or hacksaw to minimize headspace in the core. Cap the top of the liner and indicate the appropriate orientation of the sediment core using indelible ink. Process the core for erosion testing as specified in Section 5.0 of this SOP.

**4.2 Collection of Vibracores**

Depending upon the nature of the sediment it may be necessary to use a vibracoring device to collect undisturbed sediment samples in a vertical column. The core sampling will be performed in a self-propelled shallow-draft vessel with a vibracore sampler mounted on board. Cores should be collected in a

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SEDIMENT STABILITY STUDIES****October 15, 2004**

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coring device with inner and outer diameters consistent with the specifications of Sedflume provided by the designated erosion testing laboratory (SOP 350). Core length should be approximately 2 ft if the core is to be used for age dating, grain-size analysis of chemical analysis. For erosion testing, the core only needs to be approximately 1 foot in length. The clear sampling tubes are used to allow rapid visual assessment of core conditions and recovery.

At each sampling location, the following procedure should be followed:

1. Set location buoy,
2. Anchor barge or boat next to buoy using three anchor lines,
3. Record location using differential GPS,
4. Record water depth,
5. Collect first core sample,
6. Cap, label and log core,
7. Decontaminate sampling equipment following protocol in Workplan,
8. If additional cores are to be obtained at the same location, then for each additional core, move the barge approximately 5 feet within anchor lines,
9. Record water depth,
10. Collect additional core sample,
11. Cap, label and log core,
12. Decontaminate sampling equipment.

**5.0 SAMPLE HANDLING**

After collection, the cores should be transported to an onshore site for sub-sampling and packing and shipping. Two-foot cores collected for sediment age-dating analyses will also be sub-sampled for grain size distribution and chemical analyses. Sub-sampling intervals, storage and packaging procedures are discussed in the following sections.

**5.1 Sub-Sampling for Age Dating**

Two-foot sediment core samples collected for age dating (radiometric) analyses will be sub-sampled to evaluate the age of discrete sediment layers. Samples will be collected at 2 cm intervals from each archived core. The following section identifies the procedure used to sub-sample sediment cores for age-dating analyses:

1. Place a plunger or equivalent device at the bottom end of the two-foot core. The plunger or equivalent device should fit within the inner diameter of the core tube.
2. Slowly press the bottom of the core tube down on the plunger or equivalent device, extruding the top layer of sediment out of the top of the core tube.
3. Using a stainless steel trowel or spatula, slice the top layer of the core at 2 cm intervals and place the sample into a pre-labeled, clean plastic bag. (Approximately 6 grams of wet sediments will be removed at each interval.)

**COLLECTION OF CORE SAMPLES FOR  
SEDIMENT STABILITY STUDIES****October 15, 2004**

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- 
4. Repeat steps 2 and 3 until the entire core has been processed.
  5. When the entire core has been processed, homogenize each sampling interval within the plastic bag and place the sample into a pre-labeled glass jar (identifying core identification, sub-sample depth, and interval) using a stainless steel spoon or spatula. (Approximately 6 grams of wet sediments will be removed at each interval.)
  6. Decontaminate the steel spoon(s) between each sampling interval using Alconox and deionized water.
  7. The sediment samples require no special handling, and will be sent to the lab for radiometric Pb-210 and Cs-137 dating using standard laboratory techniques identified in SOP 340.

**5.2 Sub-Sampling for Grain-Size**

Samples will be collected at 2 cm intervals from each archived core. A 2 centimeter section of wet sediments will be removed at each interval and placed in a plastic bag and sealed. The bag will be labeled with the core identification and sub-sample depth and interval. The sediment samples require no special handling, and will be sent to a lab for grain-size analysis using ASTM method D 422-63.

**5.3 Sub-Sampling for Chemical Analysis**

Samples will be collected at 2 cm intervals from each archived core. A 2 centimeter section of wet sediments will be removed at each interval and placed in a plastic bag and sealed. The bag will be labeled with the core identification and sub-sample depth and interval. The sediment samples should be handled and packaged as discussed in SOP 210.

**5.4 Packing Short (1-foot) Cores for Erosion Testing**

The short cores collected for erosion testing will remain intact with no sub-sampling. Any free water near the surface of the sediment core will be drained and then a plastic disk inserted to preserve the integrity of the sediment surface. The ends of the core will then be sealed and labeled and shipped to the designated lab for erosion testing. See SOP 350 for further details.

**Standard Operating Procedure**  
**For**  
**Pore Water Sampling Using Diffusion Sampling Vessels**

Prepared by: \_\_\_\_\_

Date: \_\_\_\_\_

Reviewed by: \_\_\_\_\_

Date: \_\_\_\_\_

Approved by: \_\_\_\_\_

Date: \_\_\_\_\_

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## **1.0 SCOPE**

This Standard Operating Procedure (SOP) describes the methodology for collecting ground water samples within the ground water/surface water transition zone using diffusion sampling vessels. The equipment list and field procedures for these activities are described in detail in the sections below. Sample locations are shown on Figure 4.

## **2.0 OBJECTIVES**

- Ensure that the representative pore water samples will be collected to properly characterize site conditions.
- Ensure quality control and consistency in taking samples.
- Serve as a means to allow traceability of error(s) in sampling and data recording.

## **3.0 EQUIPMENT NEEDED**

- Appropriate PPE as specified in the HSP;
- Hollow stem auger drill rig;
- Well construction materials;
- Global Positioning System (GPS) Unit;
- Field Book/field sheets;
- Passive diffusion bags;
- Weights and cables for deploying passive diffusion bags;
- Laboratory containers
- Cooler with ice;
- Chain-of-custody forms;
- Paper towels;
- Camera and film;
- Waterproof marking pens/ink pens;
- Plastic bags;
- Decontamination supplies;
- Nitric acid; and
- Deionized water.

## **4.0 PROCEDURE**

Pore water samples from the ground water/surface water transition zone will be collected using passive diffusion bags. A typical passive diffusion bag (PDB) sampler consists of a semi-permeable membrane lay-flat tube made of LDPE between 12 and 24 inches long. The tube is closed at both ends and contains laboratory-grade deionized water that is free of VOCs. The typical diameter of a PDB sampler used in a 2-inch diameter well is 1.2 inches. An LDPE mesh on the outside of the tube is sometimes used to protect

against abrasion in open boreholes and also as a means to attach the sampler to the suspension line. PDBs used for this investigation are supplied by several vendors. Use of EON Equilibrator™ or equivalent devices is recommended. Pore water samples will be analyzed for the parameters identified in on Table 1 of the Field Sampling Plan. The number and locations for sampling are described in Section 2.5 of the Field Sampling Plan.

The PDBs will be deployed in temporary monitoring wells. These temporary wells will be installed in a borehole advanced with a hollow stem auger. The borehole will be advanced to maximum depth of 1.5 feet below the water table, approximately four feet at Kreher Park. Typical details for temporary monitoring well construction are shown on Figure 1.

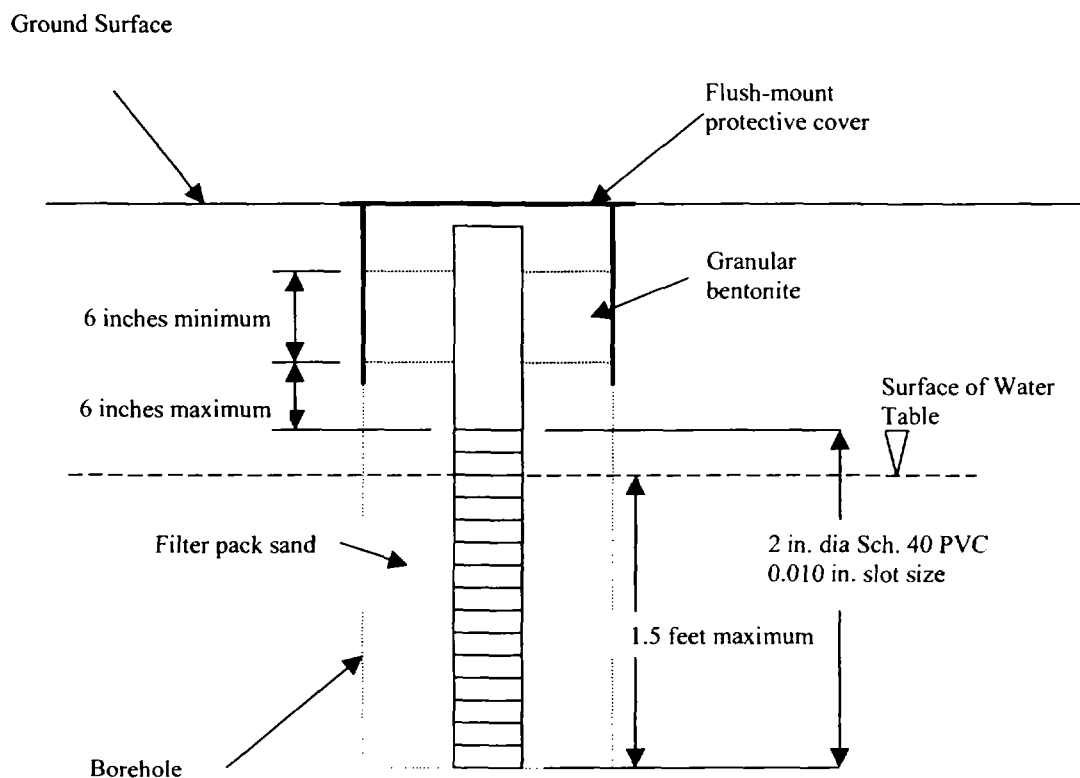
The target depth for deploying the PDB will depend upon the estimated depth of the ground water plume at the lakeshore. A decontaminated weight secured to the bottom of the mesh should be used to overcome the buoyancy of the PDB. The PDB must also be secured with a cable to the well cap to ensure that the PDB is positioned at the target depth. A one-month incubation period is required to allow for equilibration. Upon collection, the contents of the PDB will be placed in laboratory containers for analysis. The detailed procedures for collecting pore water samples are as follows:

1. At the sample location, install the temporary well as described
2. Fill the PDB with deionized water until the entire assembly is full of water.
3. Attach the weight to the PDB mesh.
4. Attach a cable or suspension cord to the top of the PDB assembly.
5. Lower the PDB into the well below the water surface into the screen zone and secure cable to well cap leaving sufficient length to ensure the PDB will be at the target depth.
6. Place well cap on well and secure using a padlock.
7. Record GPS coordinates and photograph location.
8. Allow a one-month incubation period for the PDB to equilibrate with the pore water.
9. Label laboratory sample containers.
10. Following the incubation period, remove the PDB by gently pulling on the cable.
11. Note the condition of the PDB and any deposits or discoloration.
12. Using clean nitrile gloves, rinse the exterior of the PDB using deionized water and transfer the contents of the PDB to laboratory-supplied containers.
13. As soon as possible after completing sampling, place samples on ice in a cooler.
14. Fill out chain-of-custody forms and prepare cooler for shipping according to laboratory's instructions.

**5.0 REFERENCES**

United States Environmental Protection Agency (USEPA). Methods for Collection , Storage, and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual. October 2001. EPA-823-B-01-002. Office of Water.

United States Geological Survey (USGS). User's Guide for Polyethylene-Based Passive Diffusion Bag Samplers to Obtain Volatile Organic Compound Concentrations in Wells – Part 1: Deployment, Recovery, Data Interpretation, and Quality Control and Assurance. 2001. Water-Resources Investigations Report 01-4060



**Figure 1**  
**Typical Temporary Well Construction for PDB Deployment**

**Standard Operating Procedure**  
**For**  
**Surface Water Sample Collection**

Prepared by: \_\_\_\_\_

Date: \_\_\_\_\_

Reviewed by: \_\_\_\_\_

Date: \_\_\_\_\_

Approved by: \_\_\_\_\_

Date: \_\_\_\_\_

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## **1.0 SCOPE**

This Standard Operating Procedure (SOP) describes the methodology for collecting surface water samples for chemical analysis and measuring *in situ* water quality parameters. This SOP is applicable to surface water sample collection at surface and subsurface depths in both lotic and lentic environments. For the Ashland/NSP Lakefront RI/FS, surface water will be sampled at both near-bottom and mid-water column depths for the BERA and at a mid-water column depth for the human health risk assessment. The equipment list and field procedures for surface water sampling activities are described in detail in this SOP.

Surface water sampling procedures presented here generally follow the USEPA Environmental Response Team's SOP #013 (Revision 1.0) for surface water sampling (USEPA 2002). Modification of these procedures may be required based on field conditions or equipment limitations. Actual procedures employed will be documented in the RI/FS Report. The rationale for selecting surface water sampling locations is presented in the RI/FS workplan.

## **2.0 OBJECTIVES**

- Ensure that the representative surface water samples will be collected to properly characterize site conditions.
- Use consistent methods that reduce potential for cross contamination and avoid introducing contamination as a result of poor sampling and/or handling technique.
- Serve as a means to allow traceability of error(s) in sampling and data recording.

## **3.0 EQUIPMENT NEEDED**

- Surface water samplers (Knmerer bottle, Van Dorn sampler, or peristaltic pump and tubing)
- 12 V battery (for peristaltic pump)
- Suspension lines and messengers
- Boat equipment: personal flotation devices, nautical charts, fuel, spare parts, etc.
- Field Book/field sheets
- Global Positioning System (GPS) unit
- Sample containers from laboratory
- Sample container labels
- Cooler with ice
- Chain-of-Custody forms
- Paper towels
- Camera and film
- Waterproof marking pens/ink pens
- Plastic bags
- Decontamination supplies
- Deionized water

- Water quality multi-meter (Hydrolab, SI, Horiba)

#### **4.0 PROCEDURE**

For the BERA, surface water samples will be collected on two separate occasions from six Site locations on a transect extending from the shoreline offshore beyond the area of impacted sediment. In addition, two reference stations will be sampled. Samples will be collected once when the water is calm and once following a high-energy event within 24 hours of a period when waves exceed 30 cm in height. At each station, a near-bottom sample and a mid-water column sample will be collected.

For the human health risk assessment, surface water samples will be collected along a shoreline transect at six Site locations in water two to three feet deep. In addition, two reference stations will be sampled. Samples will be collected once when the water is calm and once following a high-energy event within 24 hours following a period when waves exceed 30 cm in height. At each station, a mid-water column sample (1-1.5 foot depth) will be collected.

#### **4.1 Collection of Surface Water Samples for Chemical Analyses**

This section describes three alternative procedures for collecting surface water samples for chemical analysis. Each procedure employs a unique sampling device for collecting surface water. Sampling methods using a Kemmerer bottle, Van Dorn sampler, and peristaltic pump are described in the following sections. The sampling device must be of a proper composition to meet the goals of the study. Samplers should be constructed of glass, stainless steel, or Teflon to avoid introduction of contaminants. If sampling is conducted through the ice in freezing conditions there may be the risk of the lines freezing or other mechanical issues using the peristaltic pump.

##### **4.1.1 Kemmerer Bottle**

Kemmerer bottles are used for sampling specific depths and can be deployed from a boat, bridge, pier, or other structure. Sampling procedures are as follows:

1. Ensure that the Kemmerer bottle is properly decontaminated. Set the sampler so that the upper and lower stoppers are pulled away from the body, allowing water to enter the tube.
2. Lower the pre-set sampling device to the required depth, being careful to avoid disturbing the substrate.
3. When the Kemmerer bottle is at the required depth, send the weighted messenger down the suspension line. This action will close the sampling device.
4. Retrieve the sampler and release the first 10-20 mL from the drain to clear potential contamination from the valve. Repeat this procedure if additional sample volume is needed. Additional grabs may be composited or transferred directly to appropriately labeled sample containers.
5. Place samples on wet ice.
6. Complete appropriate Chain-of-Custody forms and ship overnight to laboratory for processing and analysis.

##### **4.1.2 Van Dorn Sampler**

Van Dorn samplers are used to collect surface water samples from a very specific depth or from a shallow water body. Sampling procedures are as follows:



1. Ensure that the Van Dorn sampler is properly decontaminated. Set the sampler so that the end stoppers are pulled away from the body, allowing water to enter the tube.
2. Lower the pre-set sampling device to the required depth, being careful to avoid disturbing the substrate.
3. When the Van Dorn sampler is at the required depth, send the weighted messenger down the suspension line. This action will close the sampling device.
4. Retrieve the sampler and release the first 10-20 mL from the drain to clear potential contamination from the valve. Repeat this procedure if additional sample volume is needed. Additional grabs may be composited or transferred directly to appropriately labeled sample containers.
5. Place samples on wet ice.
6. Complete appropriate Chain-of-Custody forms and ship overnight to the laboratory for processing and analysis.

#### **4.1.3 Peristaltic Pump**

A peristaltic pump may be used to sample surface water at specific depths. A peristaltic pump can be deployed from a boat, bridge, pier, or other platform given that the distance from the pump to the surface of the water does not exceed 27 feet. Sampling procedures are as follows:

1. Connect dedicated tubing (tygon or silicon) and a stainless steel tubing weight to the peristaltic pump.
2. Lower the stainless steel tubing weight to the required depth and start the pump.
3. Allow at least three sample-tubing volumes to field rinse the tubing, and other sample collection or processing equipment. Discard the rinse water.
4. Direct the sample flow into sample containers until a sufficient volume has been collected.
5. Repeat the process if another depth is to be sampled.
6. Replace the tubing before sampling at the next station.
7. Place samples on wet ice.
8. Complete appropriate Chain-of-Custody forms and ship overnight to the laboratory for processing and analysis.

#### **4.2 *In situ* Measurement of Water Quality Parameters**

*In situ* measurements of temperature, conductivity, and dissolved oxygen (DO) will be made at each location and depth that a surface water sample is collected. Measurements will be made with a water quality multi-meter (For example, Hydrolab, YS or Horiba). The procedures for making *in situ* measurements generally follow the USGS National Field Manual for the Collection of Water Quality data (Wilde and Radtke 2003b):

1. Prior to the sampling event, calibrate the multi-meter according to the manufacturer's guidelines. Calibration should be done daily prior to using the meter in the field. Calibration notes should be recorded in the field logbook.

2. Lower the calibrated multi-meter to the desired sampling depth and allow the meter to equilibrate. The meter should be allowed to equilibrate for at least 60 seconds. The meter will be operationally equilibrated when readings stabilize within the following ranges:
  - Temperature within 0.5°C
  - Conductivity within 3%
  - DO within 0.3 mg/L
3. Once the meter has operationally equilibrated, record the median of at least three readings for each parameter as the values for that sampling point. Enter the values in the field logbook or surface water data sheet.

## **5.0 REFERENCES**

- USEPA. 2002. Standard Operating Procedures: Surface Water Sampling. SOP #203, Rev. 1.0. Environmental Response Team. Internet document at <http://www.ertresponse.com/sops/2013-r10.pdf>.
- Wilde, F.D., Radtke, D.B., eds., 2003b, Field measurements: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A6, accessed 10/01/04 at <http://pubs.water.usgs.gov/twri9A6/>.

**Standard Operating Procedure**

**For**

**Collection of Radiometric Data for Calculation of in Situ Extinction  
Coefficients for Laboratory Ultraviolet Light Exposures**

Prepared by: \_\_\_\_\_

Date: \_\_\_\_\_

Reviewed by: \_\_\_\_\_

Date: \_\_\_\_\_

Approved by: \_\_\_\_\_

Date: \_\_\_\_\_



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## 1.0 SCOPE

This SOP provides guidance for the collection of depth-specific radiometric data (broad waveband solar radiation: UVB, 280- 320 nm; UVA, 320- 400nm; visible, 400- 700nm) suitable for the calculation of three, waveband-specific *in situ* extinction coefficients.

## 2.0 OBJECTIVES

The objective of this SOP is to provide site-specific UV light measurements that will be used to calibrate UV light exposures in laboratory bioassays of benthic invertebrates and fish. Since the benthic invertebrates inhabit the sediment-water interface where detritus is more dense than in the water column (*i.e.*, *nepheloid layer*), *one objective is to account for the lesser penetration of UV light to these organisms.* Mid-water measurements may be used to calibrate the exposures used for the fish bioassays.

## 3.0 SUMMARY OF THE METHOD

This radiometric data collection SOP involves the measurement of solar radiation at the sediment-water interface, 2 feet above the sediment, 2 feet below the water surface, and at the surface of the water of three specific wavebands of radiation, the UVB, UVA, and visible. These instructions are specific to the MACAM UV-203 ip67 radiometer.

*In situ* extinction data are plotted as the natural log of intensity (in  $\mu\text{W}/\text{cm}^2$ ) versus depth. The slope of this line is the extinction coefficient and represents the rate at which light is filtered by the overlying water column. This value may be used as a generic estimate of how intense sunlight will be at any depth measured, assuming the filtering properties of the water column are constant. At the sediment-water interface, this is not thought to be the case, but the mid-water and surface measurements may also be useful in evaluating the radiometric doses that may reach fish in the water column.

## 4.0 PERSONNEL QUALIFICATIONS

Measurement procedures will be checked by an experienced staff member (*i.e.*, project leader) prior to sending novice technicians into field sites.

## 5.0 MATERIALS AND PROCEDURES

1. Apparatus and Supplies- See attached checklist (Table 1)
2. Measurement Conditions- whenever possible, extinction data should be collected within 2 hr of local solar noon (the midpoint between sunrise and sunset), generally between 1000 and 1400 hours and during times of full sunlight. These represent worst-case UV conditions. Data should also be collected at 0800, 1000, 1400, 1600 and 1800 hours so that average UV conditions can be calculated. These are baseline data sets.
3. An attempt should also be made to record the range of possible light intensities that occur on non-sunny days. These will be used to estimate the variance of the baseline data sets.

4. Locating sites on maps- The UV radiation measurement sites will be two of the sediment sampling Triad sites. One will be at an approximate depth of four feet, the other at eight feet. UV measurements should be made prior to sediment sampling to avoid increased turbulence. Care should be taken to avoid disturbing bottom sediments, but naturally-occurring flocculent material should not be avoided since benthic invertebrates inhabit this nepheloid zone and wood chips (and other detritus) are a major unknown at the site.
5. Field Sheets- Measurement information including date, time of day, field crew ID and sampling station map will be recorded on standard field data sheets.
6. The following steps will be taken to collect extinction coefficient data:
7. The meter will be zeroed by placing the sensor head (specifically the top surface where the Teflon discs are visible) in a dark location. This can be accomplished by placing a completely light-dense object over the top surface (i.e., several layers of black plastic) or against the body (i.e., back of thigh near the knee while squatting to squeeze the sensor between the thigh and calf muscles).
8. At least 2-days prior to the commencement of UV measurements, the sensor will be placed in the sediment with the Teflon discs level with the sediment surface (i.e., 2 cm deep into the sediment. The sensor shall be attached to a weighted anchoring device and marked with a buoy. The boat shall be positioned such that dropping the anchor does not spread a sediment plume towards the sensor and the boat shadow does not affect the light measurements. The station shall be identified by GPS coordinates recorded in the prior sediment sampling.
9. If sediments are disturbed, it may be necessary to wait until the turbidity subsides or the place the sensor at the location and make the readings the next day. If the sensor can be placed in the sediment so that the sensor top is flush with the sediment, this will provide the most accurate estimate of the UV dose that epibenthic invertebrates will normally receive. The sensor cable may be attached to the station marker so that readings can be taken the following morning without disturbing the nepheloid layer.
10. Take readings at the sediment-water interface first, then take the mid-water and surface readings. Record depths as accurately as possible. Make sure the sensor is not under the boat shadow.
11. The measurement sequence will involve three separate attenuation data sets for each waveband.

Actual measurements will be taken using the averaging function. This is done as follows:

1. Set the radiometer to the wavelength range to be measured;
2. Press the MODE button once; the "average" light should come on and the readings will hold at zero;
3. *Position the sensor head and then press HOLD/RUN; the radiometer will start averaging readings. Wait 5 seconds and then press HOLD/RUN again. This will freeze the average value on the screen. Record this value and the depth;*
4. Press FUNCTION/RESET, move the sensor to the next depth and press HOLD/RUN. Wait 5 seconds and press HOLD/RUN again. Record this value and the depth.
5. Repeat this process until all depth measurements have been made.

Control of Data- All field data sheets will be reviewed at each measurement station by a member of the crew not directly involved in the collection of the specific data.

**Table 1. Required equipment and supplies**

<b>Supplies/Equipment</b>	<b>Packed</b>
SCUBA, wet suit, etc. (one per person, 2 persons)	
MACAM UV 203 ip67 radiometer, sensor, 100 ft. fiber optic data line, data logger, etc	
GPS	
Write-in the-Rain field data note book with numbered pages	
Pencils or water-proof pens	
Small boat with anchor	
Floatation devices	
Cell phone	

**Standard Operating Procedure**  
**For**  
**Sediment Toxicity Testing and Bioaccumulation**

Prepared by: \_\_\_\_\_

Date: \_\_\_\_\_

Reviewed by: \_\_\_\_\_

Date: \_\_\_\_\_

Approved by: \_\_\_\_\_

Date: \_\_\_\_\_



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## **1.0 SCOPE**

This Standard Operating Procedure (SOP) describes the methodology for conducting bulk sediment bioassays with *Hyalella azteca* with and without exposure to ultraviolet light and *Chironomus tentans* without ultraviolet light. In addition, this SOP describes a UV avoidance test with *H. azteca* and bioaccumulation tests, without UV light, with *Lumbriculus variegatus*. In general, the procedures were developed in accordance methods described in U.S. EPA (2000) with the addition of methods described in Little et al. (2000) and Barron et al. (2003).

## **2.0 OBJECTIVES**

- Ensure that the equilibrium between PAHs and sediment organic matter in the bioassays is as close as possible to that found in the field.
- Ensure that the UV light exposures in the laboratory are as close as possible as that measured in the field.
- Ensure that organisms are able to avoid UV light if that is their normal behavior.
- Obtain lethal and sublethal toxicity data.
- Obtain bioaccumulation data
- Serve as a means of delineating toxic from non-toxic sediments.

## **3.0 EQUIPMENT NEEDED**

- Standard equipment needed to conduct U.S. EPA Method 100.4 bioassays with *H. azteca* and Method 100.5 with *C. tentans* (EPA 2000)
- Standard equipment needed to conduct U.S. EPA Method 100.3 bioassays with *L. variegatus* (EPA 2000)
- Temperature-controlled water tables
- Flow-through water delivery system or daily-renewal, as available
- UVA-340 Q-Panel lamps
- Cracked-crystal light panels
- Neutral density filters or similar
- Bioassay vessels with nitex or similar covers
- 1 mL pipettes
- HPLC with fluorescence detector
- Amber HPLC vials
- Methylene chloride
- Amber Storage vials
- Drying oven
- ug balance

#### **4.0 BIOASSAY PROCEDURES**

This section describes the procedures for setting-up and conducting the bioassays with and without UV light. Conditions and requirements for conducting 28-day *H. azteca* and *C. tentans* bioassays and the *L. variegatus* bioaccumulation tests without UV light are found in U.S. EPA (2000) and are not reproduced here. Survival and growth will be the toxicity test endpoints and PAH concentrations will be the bioaccumulation test endpoint. The tests without UV light will be conducted prior to the UV light bioassays so that only those sites that were marginally toxic, or non-toxic under standard laboratory conditions will be re-tested with the potential additional stress of UV light. Only *H. azteca* will be exposed to UV light. There are no official ASTM or U.S. EPA protocols for conducting experiments with UV light exposure. However, the following UV methods are consistent with recent studies published in the primary literature (Little et al. 2000; Barron et al. 2003; Diamond et al. 2000).

##### **4.1 Sediment Re-Equilibration**

For both the normal light, and the UV light exposures, thoroughly-mixed, composited sediment samples will be provided sufficient time to re-equilibrate to expected field conditions. For this purpose, 100 mL of composited sediment will be added to each 300 mL bioassay vessel and subjected to either daily renewal or flow-through conditions identical to that which will be used in the bioassay, for a period of 20-days prior to the commencement of the bioassays. The same process will be applied to the bioaccumulation tests but the volumes will be different as described in the method. This is expected to allow for both low and high molecular weight PAHs to establish the equilibrium conditions that existed prior to sediment disturbance and to avoid any artifact that may result from disequilibrium conditions.

Once the bioassays have commenced, the overlying water will be changed daily (90%) using either static renewal or flow through system.

##### **4.2 Application of Ultraviolet Light (*H. azteca* only)**

*H. azteca* will be exposed to Site sediments and UV light only from those stations that caused marginal or no toxicity in the non-UV light bioassays.

1. Ultraviolet light doses (spectra and intensity) will simulate those found in the field study (SOP 320).
2. On a daily basis for 28-days, the field-measured dose will be applied either in natural, varying form, or as an on-off, square curve function to achieve the same dose. This will depend upon the apparatus available.
3. The UV dose may be adjusted with neutral density filters or equivalent
4. The organisms will be provided sufficient time to establish normal behavior prior to the onset of UV exposure.
5. Using a MACAM UV-203 ip67 radiometer (or equivalent), the UV dose will be monitored at the same four submerged water bath locations once each day and the data recorded (See SOP 320).

### **4.3 Chemical Analyses**

Once daily, prior to solution renewal (if a flow-through system is not available), total PAH concentrations in the overlying water shall be measured from three randomly selected replicate bioassay vessels for each station. Once the three vessels are selected, they shall be analysed daily for the duration of the study. From each of the three beakers, a 900 uL water sample will be taken by pipette, carefully avoiding aspiration of the test organisms, and placed into a 2-cm amber glass HPLC vial, stabilized with 100 uL acetonitrile, and placed into a light-tight container at 4°C. 100 uL of these samples shall be injected, without filtration, into a Hewlett-Packard 1150 HPLC (or equivalent) equipped with a C-18 reverse phase column and an HP 1046A fluorescence detector (or equivalent). The data will be expressed as total PAH in fluorescence units.

The remaining overlying water may be extracted with methylene chloride for possible positive individual PAH identification and quantification analyses using gas chromatography, mass spectrometry in single ion mode (GCMS-SIM). The overlying water from all of the beakers used for an individual station may be combined so that the individual PAHs can be extracted into a small volume of methylene chloride. This concentration from a large volume will facilitate detection of the individual compounds. The data will be expressed as ug PAH/L and may be compared against the fluorescence units and against similar data collected from the Site.

The overlying water from the bioaccumulation tests will not be extracted and analysed for individual PAHs, but total PAHs will be measured fluorometrically on a daily basis, as described above.

### **4.4 Provision for Natural UV Avoidance Behavior (*H. azteca* only)**

*H. azteca* will be exposed to Site sediments and UV light with added substrate to allow light avoidance only from those stations that caused marginal or no toxicity in the non-UV light bioassays.

- 1) One set of 28-day bioassays will include the addition of 1-cm plugs of maple or oak leaf to provide refugia from UV light.
- 2) The 1-cm plugs will be punched from leaves from an unpolluted site and soaked in deionized water for 3-weeks prior to use in the bioassay. Weekly water changes will be required to avoid bacterial overgrowth.
- 3) Sufficient soaked leaf plugs will be required to allow for 5 plugs per bioassay replicate.
- 4) The soaked leaf plugs will be added to the bioassay vessel after the organisms have burrowed and prior to the onset of UV light exposure.

### **5.0 REFERENCES**

Barron et al. 2003. Photoenhanced toxicity of aqueous phase and chemically dispersed weathered Alaska North Slope crude oil to Pacific herring eggs and larvae. Env. Toxicol. Chem. 22: 650-660.

Diamond et al. 2000. Effect of irradiance spectra on photoinduced toxicity of three polycyclic aromatic hydrocarbons. *Env. Toxicol. Chem.* 19: 1389-1396.

Little et al. 2000. Assessment of the photoenhanced toxicity of a weathered oil to the tidewater silverside. *Env. Toxicol. Chem.* 19: 926-932.

U.S. EPA. 2000. Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates. EPA 600/R-99/064.

**Standard Operating Procedure**

**For**

**Fat Head Minnow Bioassay With and Without Ultraviolet Light**

Prepared by: \_\_\_\_\_

Date: \_\_\_\_\_

Reviewed by: \_\_\_\_\_

Date: \_\_\_\_\_

Approved by: \_\_\_\_\_

Date: \_\_\_\_\_

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## **1.0 SCOPE**

This Standard Operating Procedure (SOP) describes the methodology for conducting sediment bioassays with fathead minnows (*Pimephales promelas*) with and without exposure to ultraviolet light. In general, the procedures were developed in accordance with the method described in U.S. EPA (2002).

## **2.0 OBJECTIVES**

- Ensure that the equilibrium between PAHs and sediment organic matter in the bioassays is as close as possible to that found in the field.
- Ensure that the UV light exposures in the laboratory are as close as possible as that measured in the field.
- Obtain lethal and sublethal toxicity data.
- Serve as a means of delineating toxic from non-toxic sediments.

## **3.0 EQUIPMENT NEEDED**

- Standard equipment needed to conduct U.S. EPA Method 1000 bioassays with *P. promelas* (EPA 2002)
- Temperature-controlled water tables
- Flow-through water delivery system or daily-renewal, as available
- UVA-340 Q-Panel lamps
- Cracked-crystal light panels
- Neutral density filters or similar
- Bioassay vessels with nitex or similar covers
- Aeration device (if necessary)
- 1 mL pipettes
- HPLC with fluorescence detector
- Amber HPLC vials
- Methylene chloride
- Amber Storage vials
- Drying oven
- µg balance

## **4.0 BIOASSAY PROCEDURES**

This section describes the procedures for setting-up and conducting the bioassays under normal and UV light. Conditions and requirements for conducting 7-day *P. promelas* bioassays without UV light are found in U.S. EPA (2002) and are not reproduced here. Survival and growth will be the study endpoints. The tests without UV light will be conducted prior to the UV light bioassays so that only those sites that were



marginally toxic, or non-toxic under standard laboratory conditions will be re-tested with the additional stress of UV light. There are no official ASTM or U.S. EPA protocols for conducting experiments with UV light exposure. However, the following UV methods are consistent with recent studies published in the primary literature (Little et al. 2000; Barron et al. 2003; Diamond et al. 2000).

#### **4.1 Sediment Re-Equilibration**

For both the normal light, and the UV light exposures, thoroughly-mixed, composited sediment samples will be provided sufficient time to re-equilibrate to expected field conditions. For this purpose, 100 mL of composited sediment will be added to each 500 mL bioassay vessel and subjected to either daily renewal or flow-through conditions identical to that which will be used in the bioassay, for a period of 20-days prior to the commencement of the bioassays. This is expected to allow for both low and high molecular weight PAHs to establish the equilibrium conditions that existed prior to sediment disturbance and to avoid any artifact that may result from disequilibrium conditions.

Once the bioassays have commenced, the overlying water will be changed daily (90%) using either static renewal or flow through system.

#### **4.2 Organisms**

Newly hatched larval (24 to 48-hr old) *P. promelas*, obtained from a certified-disease-free commercial supplier will be received 48 h before testing and held at 20°C in moderately hard water, and fed freshly-hatched brine shrimp (*Artemia* sp.) twice per day, at least 2-hr prior to water exchange (EPA Method 1000 or ASTM Standard E729-96). The water in the beakers will be replaced daily (90%). Excess food will be removed daily with a pipette. Food amount will be reduced proportionately as mortality occurs.

#### **4.3 Sediment Exposure System**

In both the normal light and UV light bioassays, fathead minnows will be exposed to a gradient of PAH concentrations in sediments from the Site sampling locations, as well as three reference stations. Exposures will be continued for 7-days in either a static-renewal or flow-through apparatus, with 10 organisms per replicate and 4 replicates per station (n=40/station). The exposure chambers will be glass beakers containing 100 ml of sediment and 500 mL of overlying water. The water in the beakers will be replaced daily and the replaced water will be reserved for chemical analyses including temperature, dissolved oxygen, pH, ammonia, sulfate and PAHs. If a static system is used, these measurements will be conducted prior to water change. If DO drops to a level that would be an additional stress, the turnover rate of the aqueous phase must be increased or the system must be aerated at no more than 100 bubbles/min from a 1 mL pipette. If one replicate is aerated, all replicates from all stations must be aerated.

The pH, oxygen, and salinity will be monitored daily in 12 randomly selected test beakers from each treatment. Each day, 90% of the volume in each test beaker will be replaced with fresh water. Survival of the reference station organisms must be at least 80% and average dry weight of surviving reference organisms exceeds 0.25 mg.

#### **4.4 Application of Ultraviolet Light**

Fathead minnows will be exposed to Site sediments and UV light only from those stations that caused marginal or no toxicity in the non-UV light bioassays.

1. Ultraviolet light doses (spectra and intensity) shall simulate those found in the field study (SOP 320).
2. The toxicity tests will be conducted in a cooled water bath equipped with Q-Panel UV-340 lamps.
3. The bottom of the water bath shall have a reflectance similar to that of the sediments at the site.
4. Cool-white and UVA fluorescent lamps will be timer-operated for 14 h/d. to mimic the July photoperiod in Wisconsin, thereby providing sufficient radiation to induce photo-repair mechanisms.
5. A randomization schematic will be used to assign each replicate to a water-bath position.
6. On a daily basis for 7-days, the field-measured dose will be applied either in natural, varying form, or as an on-off, square wave function to achieve the same dose. This will depend upon the apparatus available.
7. The UV dose may be adjusted with neutral density filters or equivalent
8. The filters will be replaced daily to maintain consistent lighting conditions.
9. Lamp function, photocycle intervals, water-bath level and temperature, and recirculating flow will be checked daily.
10. Using a MACAM UV-203 ip67 radiometer (or equivalent), the UV dose will be monitored at the same four submerged water bath locations once each day and the data recorded (See SOP 320).

#### **4.5 Chemical Analyses**

Once daily, prior to solution renewal (if a flow-through system is not available), total PAH concentrations in the overlying water shall be measured from the four replicate bioassay vessels for each station. From each of the four beakers, a 900 uL water sample will be taken by pipette, carefully avoiding aspiration of the test organisms, and placed into a 2-cm amber glass HPLC vial, stabilized with 100 uL acetonitrile, and placed into a light-tight container at 4°C. 100 uL of these samples shall be injected, without filtration, into a Hewlett-Packard 1150 HPLC (or equivalent) equipped with a C-18 reverse phase column and an HP 1046A fluorescence detector (or equivalent). The data will be expressed as total PAH in fluorescence units.

The remaining overlying water may be extracted with methylene chloride for possible positive individual PAH identification and quantification analyses using gas chromatography, mass spectrometry in single ion mode (GCMS-SIM). The overlying water from all of the beakers used for an individual station may be combined so that the individual PAHs can be extracted into a small volume of methylene chloride. This concentration from a large volume will facilitate detection of the individual compounds. The data will be expressed as µg PAH/L and may be compared against the fluorescence units and against similar data collected from the Site.

#### **4.6 Test Endpoints and Statistical Analyses**

A range of sediment concentration will be tested simultaneously. Fish will be observed daily for mortality and loss of equilibrium. On day 0, a subsample of 25 fish will be measured (total length), pooled, and dried in an oven at 60°C for 24 h to obtain initial dry weights. On day 7, the dry weight of fish surviving each treatment will also be measured.

Seven-day LC50, LC20, NOEC (mortality), and EC50, EC20, and NOEC (dry weight) values will be calculated as fluorescence units within the sediment station gradient. Criteria for test acceptability include variance of water quality, UV irradiance within 10% of target values, and mortality among the experiment-wise controls (0%, control UV) to less than 20%.

#### **5.0 Literature Cited**

EPA 2002. Short-term methods for estimating the chronic toxicity of effluents and receiving water to freshwater organisms. Final Rule. [www.epa.gov/OST/WET](http://www.epa.gov/OST/WET)

Little et al. 2000. Assessment of the photoenhanced toxicity of a weathered oil to the tidewater silverside. *Env. Toxicol. Chem.* 19: 926-932.

**Table 1. Summary of Test Parameters**

<b>Parameter</b>	<b>Acute fish</b>
# of replicates	4
# of organisms/replicate	10
Sediment volume per replicate	100 mL sediment
Water volume per replicate	250 mL water
Temperature (°C)	25 ± 1
Test duration	7-days
Sample treatment	Composited sediments from each station
Re-equilibrium Time	20-days daily static renewal or flow through
Feeding	Twice daily: ≈ 30 Artemia per feeding
Special treatments	UVA, UVB, visible light exposures

**Standard Operating Procedure**

**For**

**Radiometric Analyses**

Prepared by: \_\_\_\_\_

Date: \_\_\_\_\_

Reviewed by: \_\_\_\_\_

Date: \_\_\_\_\_

Approved by: \_\_\_\_\_

Date: \_\_\_\_\_

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## **1.0 SCOPE**

This Standard Operating Procedure (SOP) describes the methodology for analyzing sediments for radiometric analyses. Sediment cores approximately two feet in length will be collected from six offshore locations and processed according to the procedures outlined in SOP 290. Following collection and processing, samples will be delivered wet to the designated laboratory for radiometric analyses. The following sections identify general procedures for conducting radiometric analyses on the core samples; detailed analytical protocols will be provided by the laboratory when it is selected.

## **2.0 EQUIPMENT NEEDED**

- 3" x 3" NaI(Tl) detector ( $^{137}\text{Cs}$ )
- Alpha spectrometer ( $^{210}\text{Pb}$ )
- Distillation apparatus

## **3.0 PROCEDURES**

The following sections identify procedures for analyzing cesium-137 ( $^{137}\text{Cs}$ ) and lead-210 ( $^{210}\text{Pb}$ ) from each sediment layer:

### **3.1 Cesium-137**

Samples from each sediment layer will be analyzed for Cs-137 using gamma spectroscopy (gamma emissions at 661 KeV) based on the following procedures:

1. Dry the wet sediment samples received by the laboratory.
2. Analyze the samples for 24 hours using a 3" x 3" NaI(Tl) detector encased in two inches of lead shielding (to limit count contributions from sources other than the sample).
3. Target detection limit of the analysis should be 1.0 disintegration per minute (dpm/g) or lower.
4. QA/QC procedures include a monthly check of detector efficiency against an NBS spiked clay standard, using geometry vs. efficiency standard curves.

### **3.2 Lead-210**

$^{210}\text{Pb}$  is determined in sediments via its granddaughter polonium-210 ( $^{210}\text{Po}$ ) based on Eakins and Morrison (1978). Samples from each sediment layer will be analyzed for Pb-210 using alpha spectroscopy based on following procedures:

1. Convert  $^{210}\text{Po}$  to its chloride salt and distill from sediment at 500° C in a simple distillation apparatus.
2. Digest the  $^{210}\text{Po}$  distillate in a nitric acid medium, converting it back to the chloride salt, and plate out on silver.
3. Count  $^{210}\text{Po}$  by alpha spectroscopy over an 8-hour counting period.
4. Monitor the recovery of  $^{210}\text{Po}$  by simultaneously measuring the activity of a  $^{209}\text{Pb}$  spike added at the beginning of sample processing.
5. Detection limits are on the order of 0.1 dpm/g (0.0017 Bq/g) for about an 8-hour counting period and a 0.5 g sample mass.

6. QA/QC procedures include a duplicate and blank analysis every fifteenth sample.

#### **4.0 REFERENCES**

Eakins, J.D., and Morrison, R.T. 1978. A new procedure for the determination of lead-210 in lake and marine sediments. *International Journal of Applied Radiation and Isotopes*, 29:531-536.

**Standard Operating Procedure**

**For**

**Laboratory Procedures for Benthic Macroinvertebrate Community Analysis**

Prepared by: \_\_\_\_\_

Date: \_\_\_\_\_

Reviewed by: \_\_\_\_\_

Date: \_\_\_\_\_

Approved by: \_\_\_\_\_

Date: \_\_\_\_\_



**Laboratory Procedures for**  
**Benthic Macroinvertebrate Community Analysis****October 15, 2004**Page 2 of 3

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**Laboratory Procedures for  
Benthic Macroinvertebrate Community Analysis****October 15, 2004**

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**1.0 Laboratory Procedures for Benthic Macroinvertebrate Community Analysis**

In the laboratory, the following procedures are to be followed for sorting and taxonomic identification of samples:

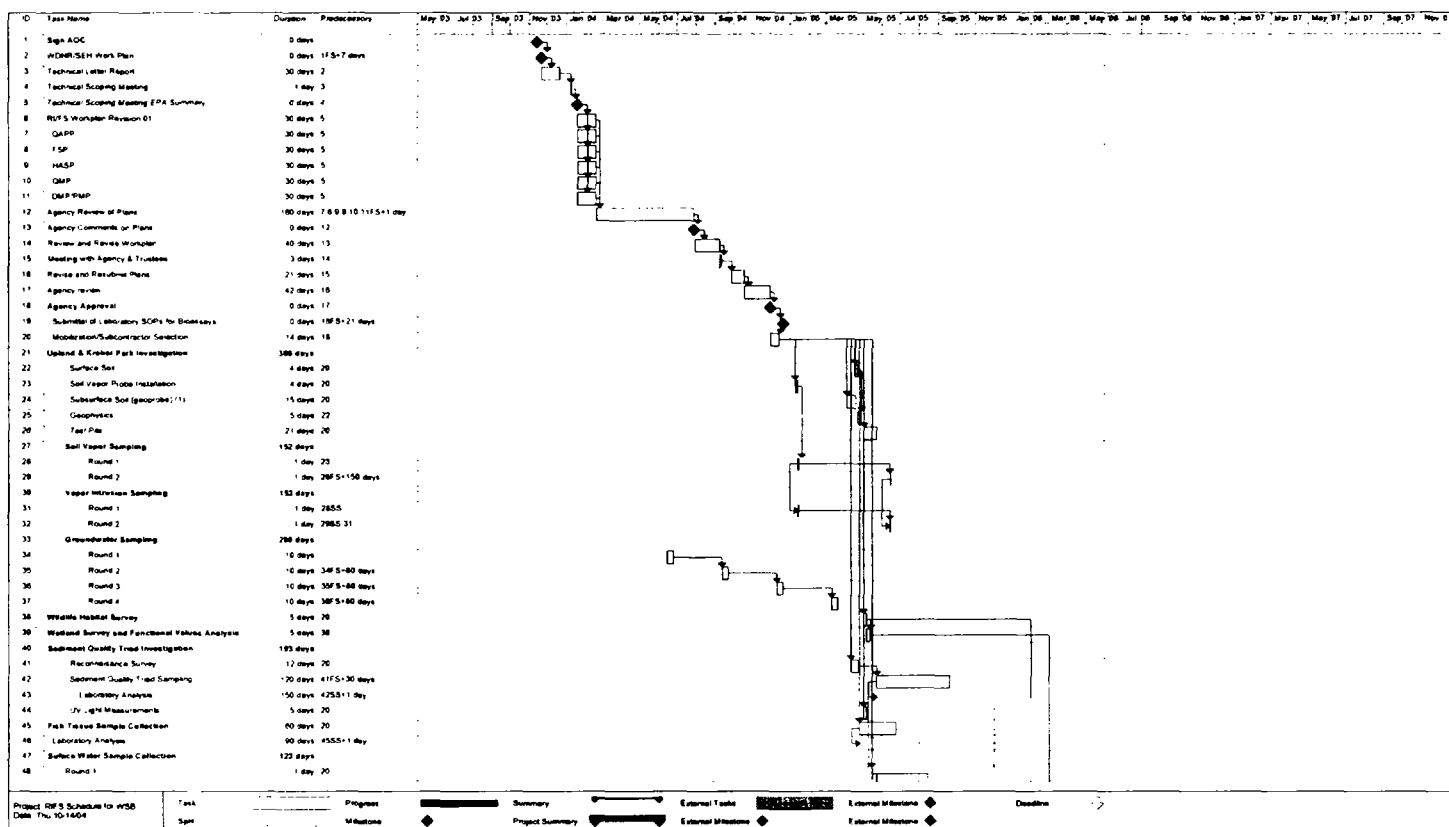
1. Rinse sample through a 500 micron mesh sieve to remove excess alcohol and detritus.
2. Spread rinsed sample evenly over a numbered grid at the bottom of a sorting tray.
3. Select one grid using a random number table and remove all organisms from within the grid.
4. Randomly selected subsequent grids until a minimum of 100 organisms are obtained. If the total sample has less than 100 organisms then all will be identified.
5. Place organisms into vials of 70% ethanol, sorted by major taxonomic grouping.
6. When the entire sample has been sorted, preserve the remaining sediment in 70% ethanol for QA/QC analysis.
7. Identify all organisms removed from each sample to the lowest possible taxonomic unit, generally to the level of genus. Identification of organisms may be performed using both dissecting and compound microscopes. The most current manuals and publications are to be used for identifications. Overall taxonomy will follow Merritt and Cummins (1997) or Pennak (1989); additional group-specific keys for dominant groups will be consulted as necessary.
8. Place identified organisms into vials of 70% ethanol for taxonomic verification.
9. Approximately ten percent of the total number of replicate samples or sampling trays will be re-examined following the sorting procedures to ensure complete and accurate sorting. If more than 20 percent of the total number of organisms has been missed, all replicate samples sorted by that person shall be re-examined.
10. Information regarding identification and abundance is to be recorded on data sheets.

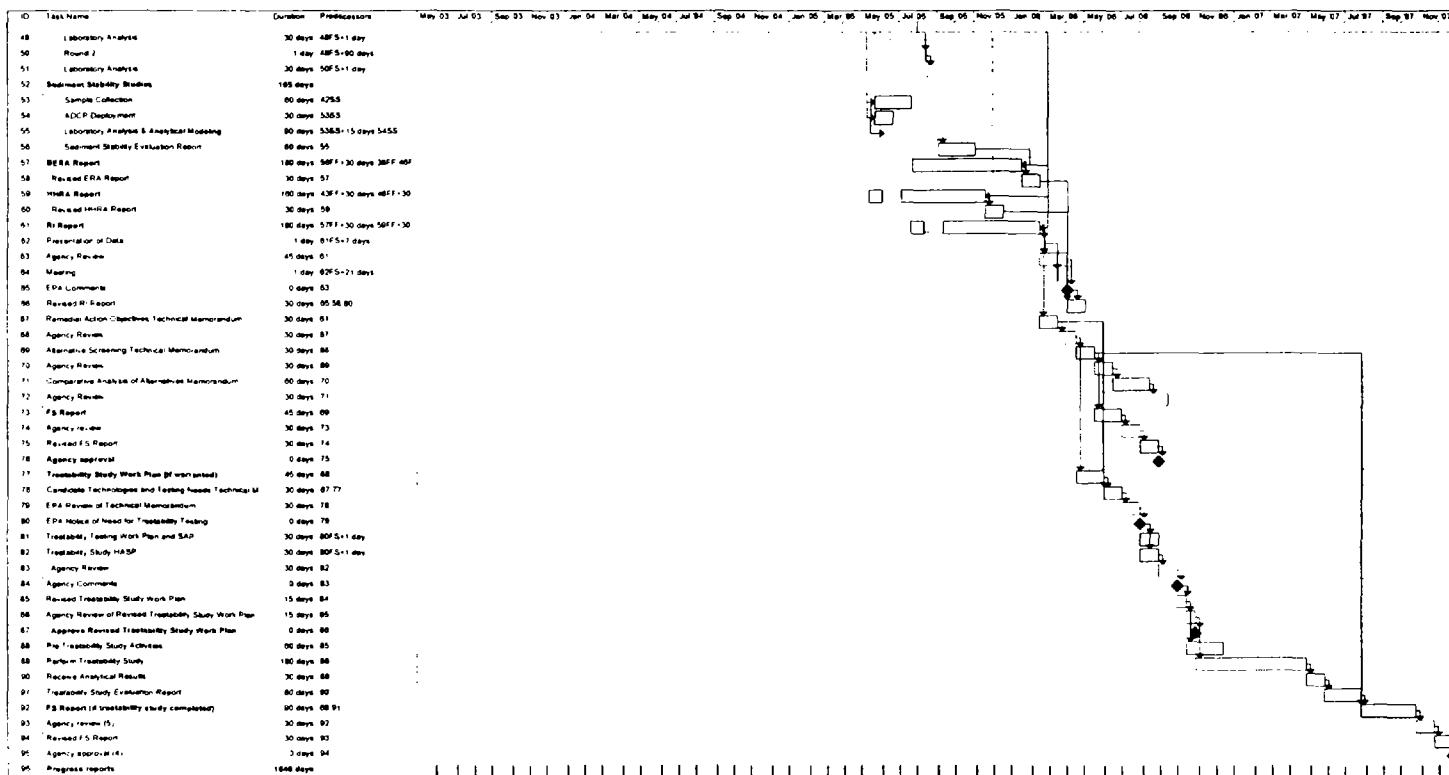
**2.0 REFERENCES**

- Merritt, R.W. and Cummins, K.W. 1997. An introduction to the aquatic insects of North America. Third Edition. Kendall/Hunt Publ. Co., Dubuque, Iowa.
- Pennak, R.W. 1989. Fresh-water invertebrates of the United States. John Wiley and Sons, New York. 628p.

## **APPENDIX B**

### **RI/FS SCHEDULE**





Project: R&S Schedule for AY58 Case: 744-10-004	Task	Progress	Summary	External Tests	Internal Milestone	Deliverables
	See	Milestone	Project Summary	External Milestone	External Milestone	

## **APPENDIX C**

### **SEDFLUME WORKPLAN**

# **Seafloor Mine Plan**

Prepared for:  
Chris Reed, Ph.D.

URS Corporation

Prepared by:

Craig Jones

Sea Engineering, Inc.  
200 Washington Street, Suite 210  
Santa Cruz, CA 95060

Tel: (831) 421-0871  
Fax: (831) 421-0875



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# Preliminary Sedflume Work Plan

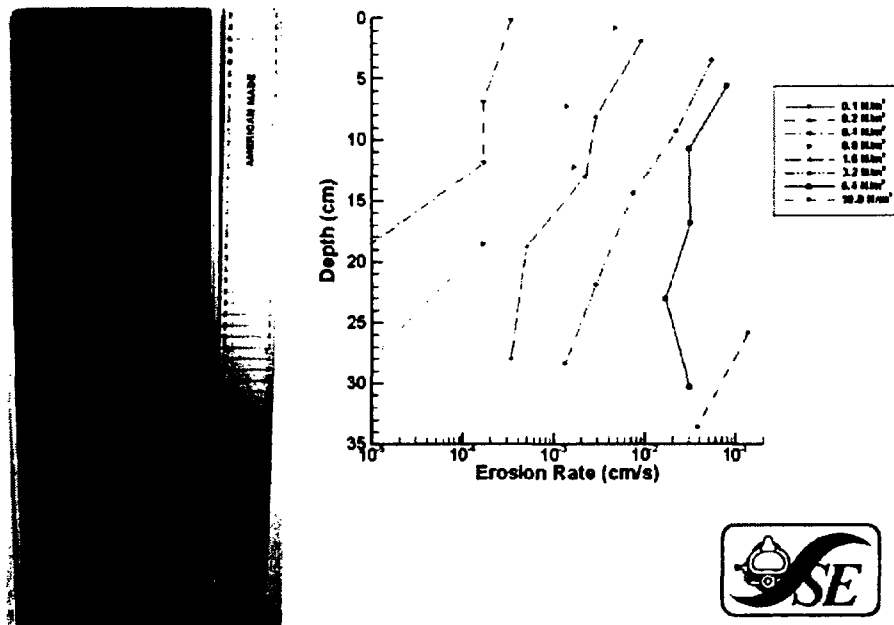
## Introduction

Sedflume sampling will be undertaken by Sea Engineering, Inc. (SEI) to determine sediment erosion rates laterally and with depth at sites to be chosen. An undefined Sedflume cores up to 1 m in length will be taken for the analysis of erosion rates. The direct measurement of sediment erosion rates via Sedflume provides a quantitative measurement of sediment stability that can be used to determine the potential for sediment mobility in a natural system (McNeil et al., 1996). It has additionally been demonstrated that erosion rates are strongly dependent on the bulk density of the sediments (Jepsen et. al, 1997; Roberts et. al, 1978). Because of this, the densities of the Sedflume cores will be determined by sub-sampling locations within each core so that the bulk density can be determined through wet/dry sample weight. Particle size analysis will be performed at additional sub-sampled locations in the cores to provide additional characterization of the sediments. These cores will be spatially located so as to delineate the different types of sediments (clays, silts, sands, etc.) present as well as along areas where concentrations of contaminants are the highest so as to characterize potential contaminant mobility.

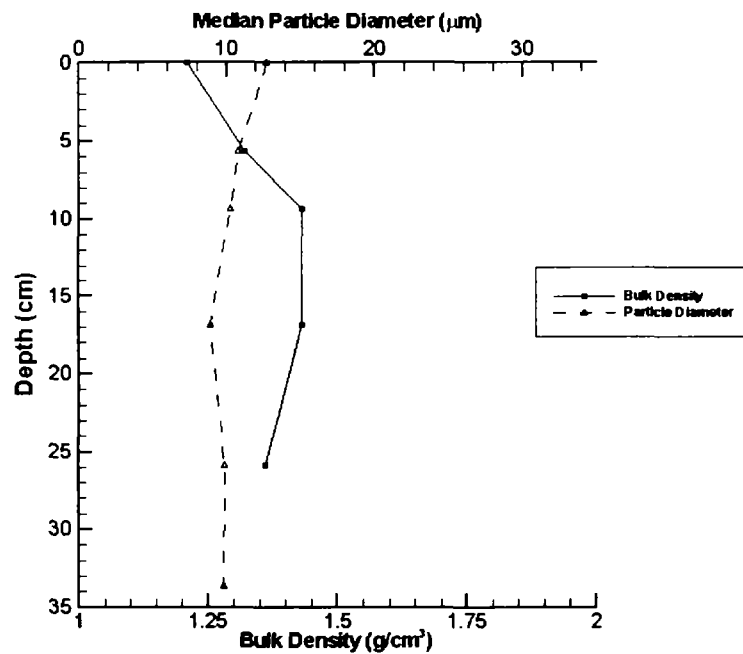
Figures 1 and 2 show sample Sedflume data from independent studies conducted at test sites in San Francisco Bay by SEI. Figure 1 shows variation of sediment erosion rates with depth into the sediments and shear stress. It can be seen in this plot that the surficial sediments erode easily at lower sediments, but at lower levels in the core the sediments are much more difficult to erode requiring much larger shear stresses. Figure 2 shows particle size and bulk density variation for the same core as Figure 1.

The objective of the Sedflume study is to characterize the erosion rates and sediment stability of sediments throughout the region of interest. Sediment characteristics such as mean particle size, particle size distribution, and bulk density will be determined with depth for each core obtained. The information collected in this study can be used to provide parameters for a sediment/contaminant transport model to estimate storm-induced resuspension of sediment and subsequent release of contaminants.

Data collected in the study will be gathered into and summarized in a detailed data report. Plots of erosion rate versus core depth and bulk parameters versus core depth will be presented for each core obtained and average erosion rates and average bulk properties will be plotted with binned depth. General trends in the data set will be noted and variations between different regions will be characterized. Quality assurance objectives and results will be assuaged in the process of preparing the report. Measurements to be made by Sea Engineering, Inc. (SEI) are shown in Table 1. These measurements will be made by instrumentation provided by the laboratory of SEI. No other special personnel or equipment is necessary for core analysis.



**Figure 1.** Erosion rate variation with depth and shear stress for San Francisco Bay location.



**Figure 2.** Variation of particle size and bulk density with depth for San Francisco Bay location.

## Data Quality Objectives for Measurement Data

To achieve the project's overall data quality objectives, measurements will be made to ensure sufficient characterization of sediment bulk properties and erosion rates. The bulk properties to be measured by SEI have been chosen based on previously determined field and laboratory work (McNeil et al, 1996; Taylor et al, 1996; Jepsen et al, 1997; and Roberts et al, 1998). The parameters to be measured in the Sedflume cores are listed in Table1.

**Table 1**

	Definition	Units	Detection Limit	Int. Consistency
Bulk Density, $\rho_b$ (wet/dry weight)	$\rho_b = \frac{\rho_w \rho_b}{\rho_w + (\rho_b - \rho_w)W}$	g/cm <sup>3</sup>	Same as water content	$\rho_w < \rho_b < 2.6\rho_w$
Grain Size	Volume weighted distribution including median and mean size	μm	TBD	TBD
Water Content	$W = \frac{M_w - M_d}{M_w}$	none	0.1g in sample weight ranging from 10 to 50 g	$0 < W < 1$
Erosion Rate	$E = \Delta z/T$	cm/s	$\Delta z > 0.5\text{mm}$ $T > 15\text{s}$	None

$M_w$  = wet weight of sample

$M_d$  = dry weight of sample

$\Delta z$  = amount of sediment eroded

T = time

$\rho_w$  = density of water

All essential bulk properties will be measured from the same core.

## **Field Methods**

### ***Sampling Process Designs***

Sediment erosion rates will be determined horizontally and with depth. Erosion rates will be measured as a function of shear stress and depth for each core. Sediment bulk properties will also be measured for each erosion core. Bulk properties of the sediments (particle size distribution, organic content, mineralogy, and gas content) will be measured using samples from the erosion core. All essential bulk properties (including erosion rates) will be measured for the same core using this method. All measurements to be taken (Table 1) are classified as critical measurements.

Approximately 6 cores will be processed in Sedflume to determine how sediment erosion potential and bulk parameters vary spatially in the study area. The number of cores chosen represents the number required to characterize the different sediment types that exist in the region and their spatial variation, while not making the study's duration prohibitively long. Approximately one day is required to process a core in Sedflume, so 6 cores represents approximately one week in the field. Erosion rates are dependent upon, at least, the following parameters: bulk density, mean grain size, grain size distribution, gas content and organic content. Sediment erosion cannot at present be predicted through knowledge of bulk parameters. Therefore, a sufficient number of cores are necessary to present adequate average erosion rates for a given aquatic system. Preferably these averages will also be grouped in terms of size class of particles, especially delineating sands from cohesive sediments.

Coring locations will be chosen with the following tenants in mind: a) sediments known to contain a relatively large amount of contaminant must be characterized, b) a wide variety of sediment types commonly found in the area, c) and knowledge of sediment variability both aerially and with water depth is necessary as sediment resuspension and deposition are strong functions of applied shear stress and water depth. Using the above criterion as guidelines, coring transects will be selected as appropriate.

### ***Core Collection and Preparation***

In situ coring will be done in the following manner aboard the vessel selected for coring. Core tubes are inserted into a thin stainless steel sleeve. The neck of the sleeve is a 10 by 15 cm outer tube, while the main body is a circular barrel with dimensions such that the 10 by 15 cm core tube fits tightly into the barrel. A nose cone with two rectangular flaps then fits onto the bottom of the barrel and holds the core tube in place.

Upon penetration of the core barrel into the sediment bed, the flaps open upwards and allow the sediment to enter the core tube without disturbing the sediment strata. When the barrel is lifted from the sediment bed, the flaps close and retain the sediment core.

The assembled coring sleeve is lowered to the sediment bed by a pole, a gravity core, or by the Vibracore. Appropriate methods will be chosen for the specific vessel and water

depth encountered. Pressure is applied to the top of the sleeve, and the nose cone. Due to its weight and the applied pressure, the sleeve penetrates into the sediment bed. The coring sleeve is then pushed as far as possible into the sediment bed; the distance of penetration will vary due to the characteristics of the sediment (i.e., further penetration will occur in a softer sediment than in a more compact sediment). This results in a sediment core that is obtained relatively undisturbed from its natural surroundings. The coring sleeve is then brought back up and lifted onto the boat deck, the nose cone is removed, and the barrel lifted off the core tube. A plug is slid up into the core tube to act later as a piston, and the core is then capped. Sediment cores varying in length from 25-100 cm will be obtained by this method.

Cores will immediately be visually inspected for length and quality. Cohesive sediments that show signs of disturbance during the coring process will be discarded and another core will be taken from that site. When non-cohesive sands are obtained at a given site, the core will be reconstructed in Sedflume cores. Approved cores will be capped and stored on deck until returned to the processing site on shore. At the processing site, samples taken from the core for bulk property analysis will be placed in appropriate sized containers, labeled, sealed, and preserved until delivered to the laboratory for analysis. Dr. Craig Jones will be responsible for corrective action regarding sample method requirements.

### ***Sample Handling and Custody Requirements***

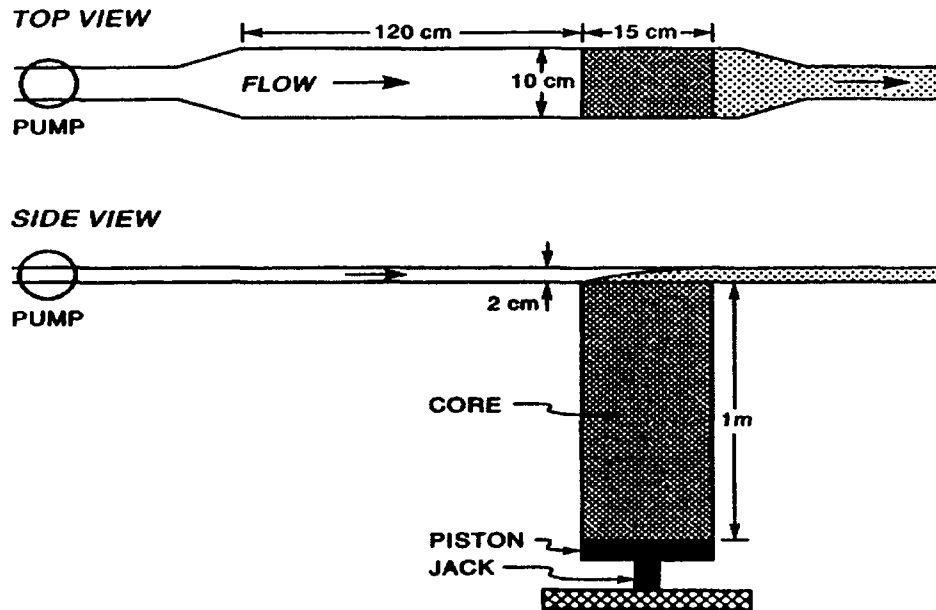
Samples will be collected, handled, and analyzed by SEI personnel. Chain of custody will be recorded as required by project specifications.

All samples will be uniquely labeled and logged by the sampler. Samples designated for Sedflume study will be under the continuous custody of SEI personnel so the sample integrity can be assured. Dr. Craig Jones of SEI will supervise all Sedflume operations.

## **Analytic Methods**

### ***Description of Sedflume***

A detailed description of Sedflume and its application are given in McNeil et al, 1996. Sedflume is shown in Figure 3 and is essentially a straight flume that has a test section with an open bottom through which a rectangular cross-section coring tube containing sediment can be inserted. The main components of the flume are the coring tube; the test section; an inlet section for uniform, fully-developed, turbulent flow; a flow exit section; a water storage tank; and a pump to force water through the system. The coring tube, test section, inlet section, and exit section are made of clear acrylic so that the sediment-water interactions can be observed. The coring tube shown in Figure 3 has a rectangular cross-section, 10 cm by 15 cm, and can be up to 1 m in length. Sea Engineering, Inc. additionally uses a 10 cm diameter circular core for Sedflume analysis to facilitate field collection of cores.



**Figure 3. Schematic of Sedflume**

Water is pumped through the system from a 120 gallon storage tank, through a 5 cm diameter pipe, and then through a flow converter into the rectangular duct shown. This duct is 2 cm in height, 10 cm in width, and 120 cm in length; it connects to the test section, which has the same cross-sectional area and is 15 cm long. The flow converter changes the shape of the cross-section from circular to the rectangular duct shape while maintaining a constant cross-sectional area. A three-way valve regulates the flow so that part of the flow goes into the duct while the remainder returns to the tank. Also, there is a small valve in the duct immediately downstream from the test section that is opened at higher flow rates to keep the pressure in the duct and over the test section at atmospheric conditions.

At the start of each test, the coring tube is filled with undisturbed sediments from the bottom of the body of water of interest or reconstructed sediments for consolidation studies. The coring tube and the sediment it contains are then inserted into the bottom of the test section. An operator moves the sediment upward using a piston that is inside the coring tube and is connected to a screw jack with a 1 m drive. The jack is driven by either electric motor or hand crank. By these means, the sediments can be raised and made level with the bottom of the test section. The speed of the jack movement can be controlled at a variable rate in measurable increments as small as 0.5 mm.

Water is forced through the duct and the test section over the surface of the sediments. The shear produced by this flow causes the sediments to erode. As the sediments in the core erode, they are continually moved upwards by the operator so that the sediment-

water interface remains level with the bottom of the test and inlet sections. The erosion rate is recorded as the upward movement of the sediments in the coring tube over time.

### ***Measurements of Sediment Erosion Rates***

The procedure for measuring the erosion rates of the sediments as a function of shear stress and depth will be as follows. The sediment cores will be obtained as described above and then moved upward into the test section until the sediment surface is even with the bottom of the test section. A measurement is made of the depth to the bottom of the sediment in the core. The flume is then run at a specific flow rate corresponding to a particular shear stress. Erosion rates are obtained by measuring the remaining core length at different time intervals, taking the difference between each successive measurement, and dividing by the time interval.

In order to measure erosion rates at several different shear stresses using only one core, the following procedure is used. Starting at a low shear stress, the flume is run sequentially at higher shear stresses with each succeeding shear stress being twice the previous one. Generally about three shear stresses are run sequentially. Each shear stress is run until at least 2 to 3 mm but no more than 2 cm are eroded. The time interval is recorded for each run with a stopwatch. The flow is then increased to the next shear stress, and so on until the highest shear stress is run. This cycle is repeated until all of the sediment has eroded from the core. If after three cycles a particular shear stress shows a rate of erosion less than  $10^{-4}$  cm/s, it will be dropped from the cycle; if after many cycles the erosion rates decrease significantly, a higher shear stress will be included in the cycle.

### ***Measurements of Critical Shear Stress for Erosion***

A critical shear stress can be quantitatively defined as the shear stress at which a very small, but accurately measurable, rate of erosion occurs. In the present study, this rate of erosion is chosen to be  $10^{-4}$  cm/s; this represents 1 mm of erosion in approximately 15 minutes. Since it would be difficult to measure all critical shear stresses at exactly  $10^{-4}$  cm/s, erosion rates are generally measured above and below  $10^{-4}$  cm/s at shear stresses which differ by a factor of two. The critical shear stress is then linearly interpolated to an erosion rate of  $10^{-4}$  cm/s. Critical shear stresses will be measured as a function of depth for both the field and the laboratory sediment cores.

### ***Description of Consolidation Studies***

Wet sediments obtained from various field sites will be mixed separately into homogeneous mixtures. These well-mixed sediments will be poured into several 20 cm cores and then allowed to consolidate for time periods up to 60 days. All bulk properties for each sediment mixture will remain constant except for bulk density. Bulk density as a function of depth will be measured periodically during the test and some cores will be sacrificed and tested in the Sedflume for erosion rates. This method gives erosion rates as a function of bulk density for each sediment mixture.

### ***Measurements of Sediment Bulk Properties***

Particle size and bulk density measurements will be conducted using standard laboratory analysis. These will be detailed in later documents.

### ***Quality Control Requirements***

Although great care will always be taken, quality control will be performed routinely during sampling and measuring.

Sediment erosion rates are related to shear stresses that are applied at particular flow rates in the channel of the Sedflume. The initial flow rate used will be that which sediment erosion is observed to begin. The flow rates, as measured by the flow meter, will be checked daily by directly measuring the volume of water collected over time at the outlet of the channel. If the flow rates are not correct, the paddle wheel of the flow meter will be cleaned and inspected. If this does not correct the problem, a new flow meter will be installed.

All instruments used for bulk density analysis will be tested with standards before and after each testing period.

Particle size measurements will be run in duplicate to check for accuracy. Also, known standards will be measured before and after each testing period.

### ***Instrument/Equipment Testing, Inspection and Maintenance Requirements***

The Sedflume flow rates and all instrumentation will be tested daily before each test run. The particle size measurements will be tested against known standards.

Sedflume is designed as a field device and as such is a fairly robust system. Spare parts for Sedflume and for the coring operation are either available at any hardware store, or may be made by any competent machine shop.

### ***Instrument Calibration and Frequency***

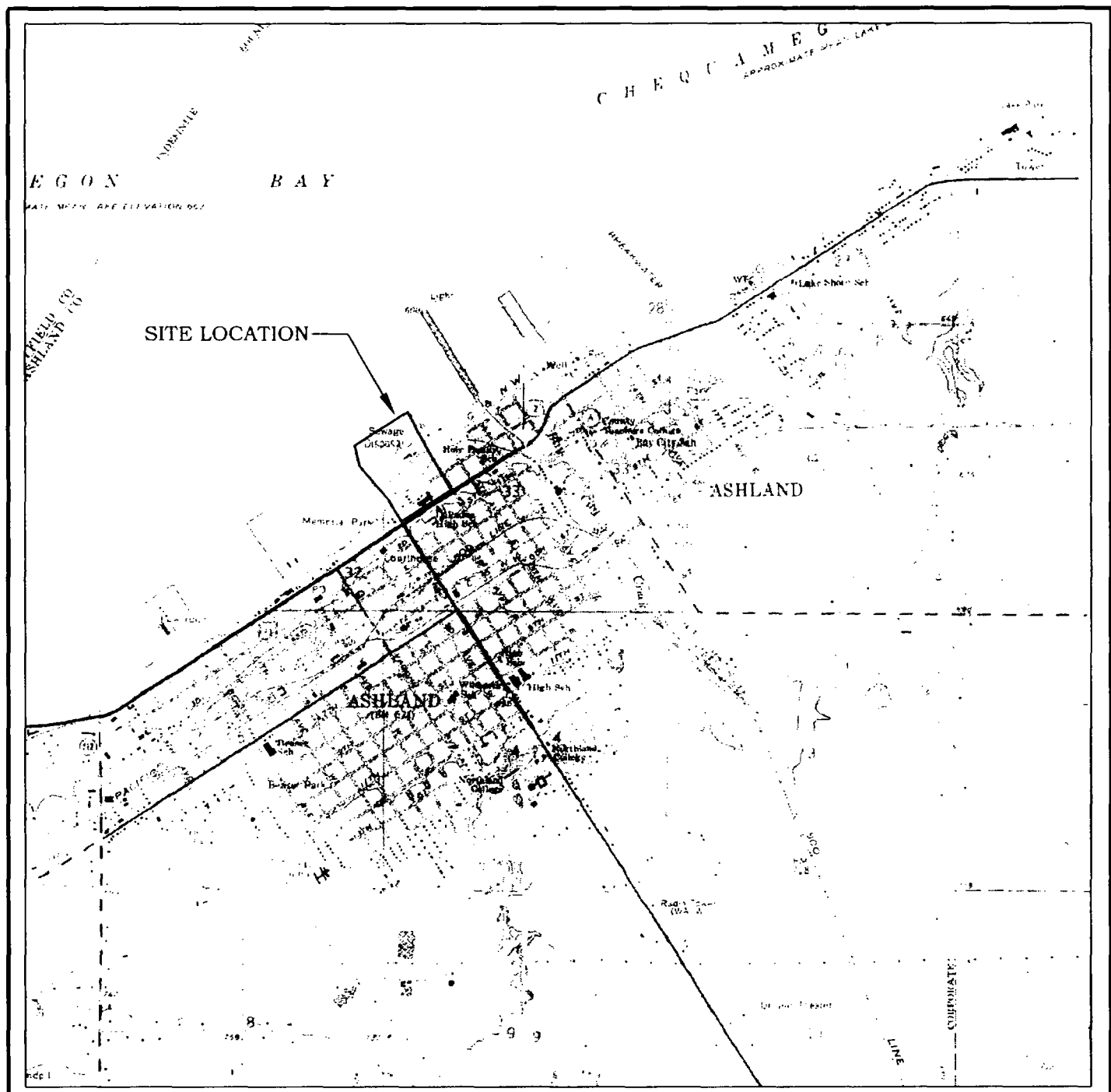
No instruments used in the Sedflume study require calibration. All instruments will be tested as described previously.



## References

- Jepsen, R., J. McNeil, and W. Lick, 1999. Effects of Gas Generation on the Density and Erosion of Sediments from the Grand River, Report, Department of Mechanical and Environmental Engineering, University of California, Santa Barbara, CA 93106.
- Jepsen, R., J. Roberts, and W. Lick, 1997, Effects of Bulk Density on Sediment Erosion Rates, Water, Air, and Soil Pollution, Vol. 99, pp. 21-31.
- McNeil, J., C. Taylor, and W. Lick, 1996, Measurements of Erosion of Undisturbed Bottom Sediments with Depth, J. Hydraulic Engineering, 122(6) pp. 316-324.
- Roberts, J., R. Jepsen, and W. Lick, 1998, Effects of Particle Size and Bulk Density on the Erosion of Quartz Particles, J. Hydraulic Engineering, 124(12) pp. 1261-1267.
- Taylor, C. and W. Lick, 1996, Erosion Properties of Great Lakes Sediments, UCSB Report.

## Figures



BASE MAP SOURCE: USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE, ASHLAND, WISCONSIN, DATED 1964, PHOTOREVISED 1975.




QUADRANGLE LOCATION



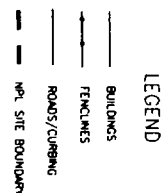
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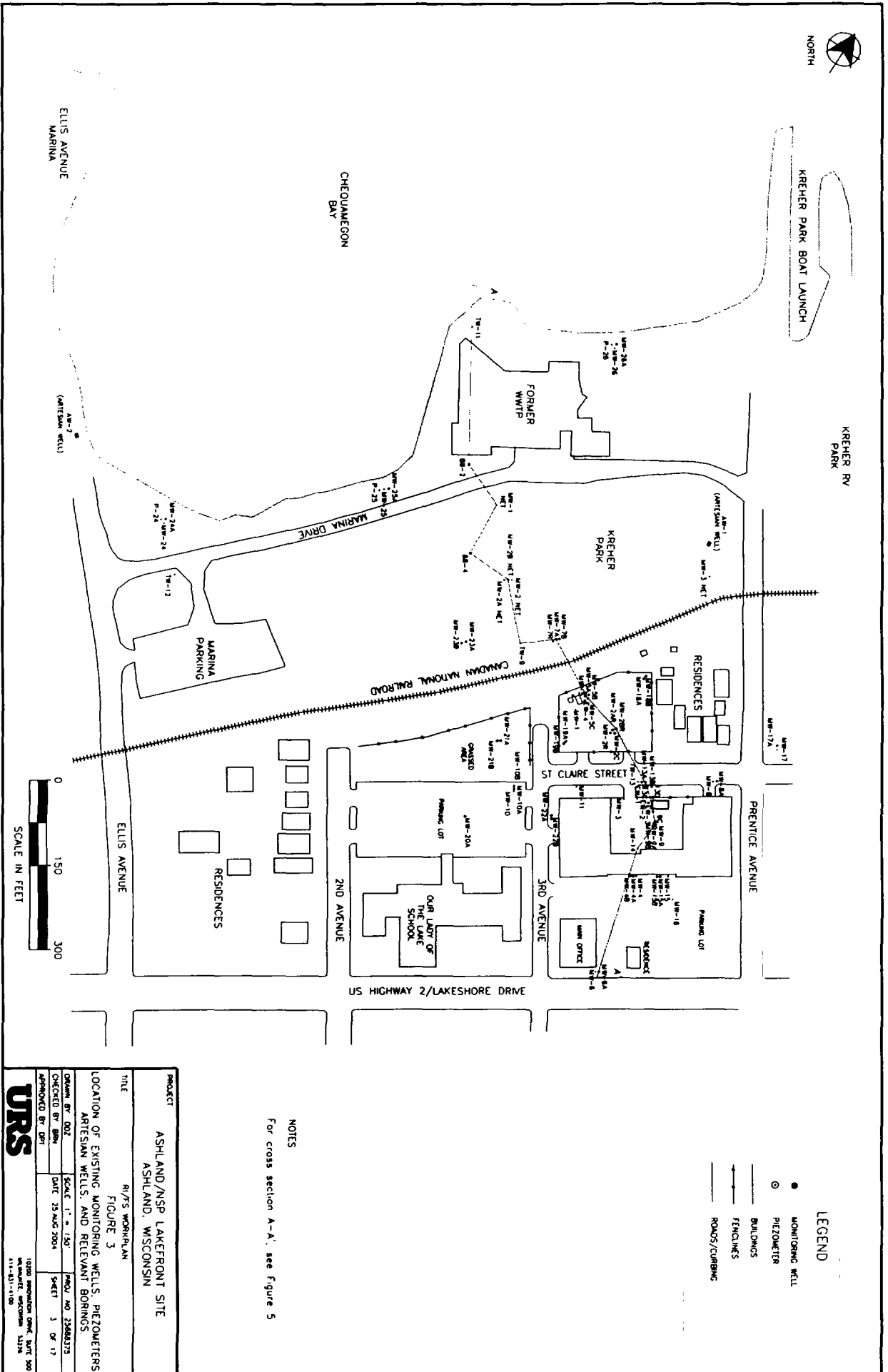
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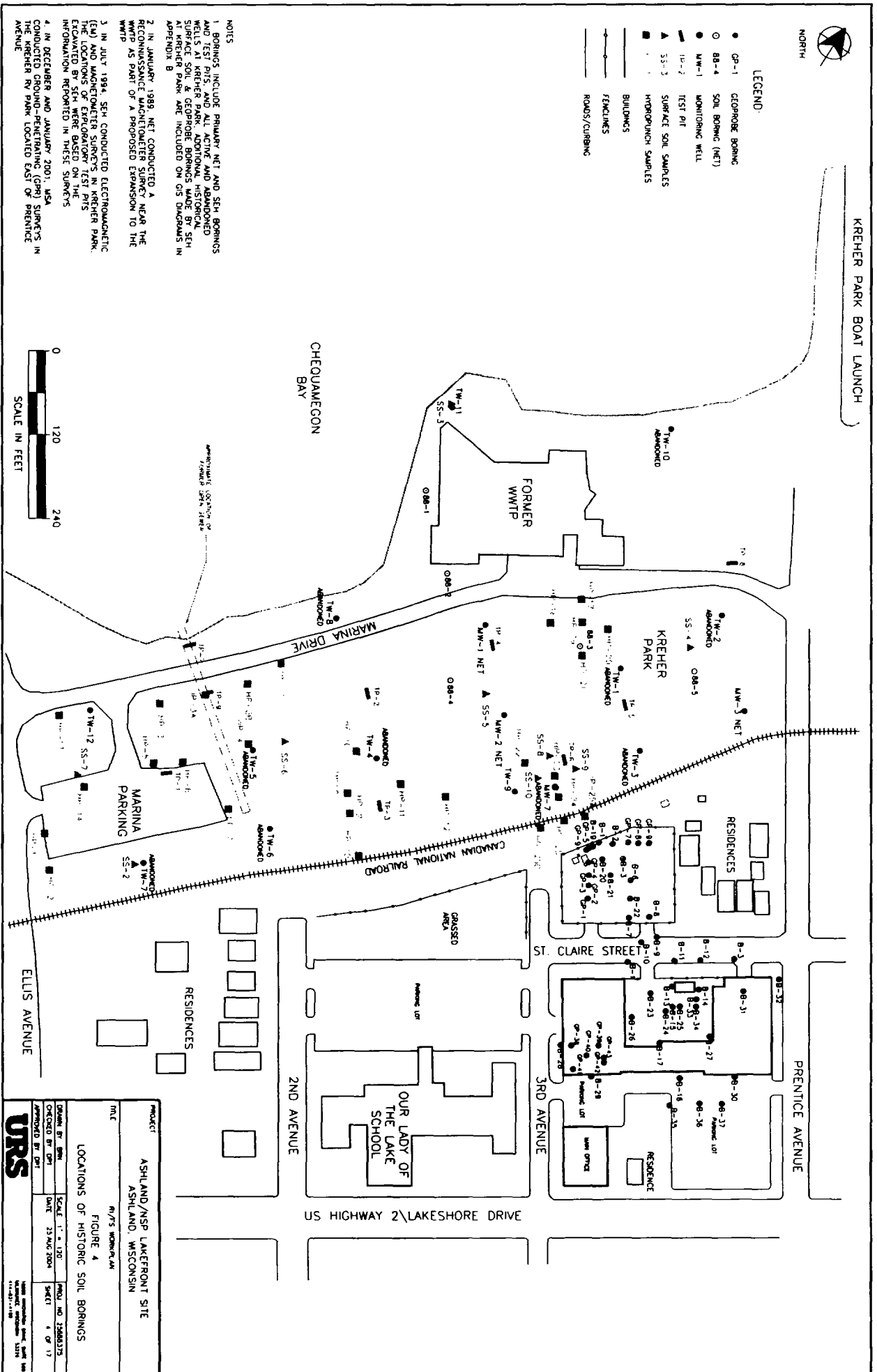
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RI WORKPLAN



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